Vitamin C in the Inuit Diet: past and present

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RÉSUMÉ

Ce mémoire explore le rôle de la vitamine C dans la diète Inuit à travers l'analyse des sources traditionnelles de nourriture, l'évaluation de la consommation contemporaine chez les femme âgées entre 20 à 40 ans, l'estimation de la consommation de la vitamine C avant le contact avec l'alimentation contemporaine et des entrevues qualitatives afin de mettre en contexte les choix actuels de nourriture qui peuvent affecter la consommation de la vitamine C. Ce mémoire fournit le premier rapport sur les valeurs de la vitamine C pour plusieurs denrées alimentaires traditionnelles des Inuit. Leur nourriture traditionnelle contient des sources importantes en vitamine C même si elles ne sont pas consommées fréquemment par ce groupe de femmes. En moyenne, la moitié des femmes interviewées à chaque saison atteint la consommation de 30 mg par jour suggérée par les apports nutritionnels recommandés au Canada (ANR) en 1990. Par contre, seulement 34 % du groupe consomme 60 mg par jour comme le recommande les nouveaux apports nutritionnels de références (ANR) 2000. Historiquement, une quantité amplement suffisante de vitamine C était obtenu lors du système alimentaire traditionnel Inuit.

ABSTRACT

This thesis explored the place of vitamin C in the Inuit diet through analysis of traditional food sources, assessment of contemporary intake among women aged 20 - 40 years, estimation of a pre contact intake of vitamin C and qualitative interviews to contextualize current food choices that can affect vitamin C intake. This thesis provides the first reports of vitamin C values for several Inuit traditional foods. There are rich sources of vitamin C in the Inuit traditional food although they are infrequently consumed by this group of women. On average half of the women interviewed in each season met the 1990 Recommended Nutrient Intake (RNI) set at 30 mg/day, however, only 34% of the group met the new Estimated Average Requirement (EAR) of 60 mg/day. Historically, ample vitamin C was obtained through the traditional Inuit food system.

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TABLE OF CONTENTS

IV. RESULTS & DISCUSSION CONT'D

LIST OF FIGURES

LIST OF TABLES

PAGES

I. BACKGROUND

1. Introduction

A common question posed by people interested in Inuit adaptation to Arctic environs pertains to our lack of knowledge with respect to the nutritive value of the traditional food system. This thesis explored the place of vitamin C in the historical and contemporary diet of the Inuit through the quantification of ascorbic acid in traditional food and the application of this data in current and historical dietary intake estimates.

Inuit have inhabited the Arctic and Subarctic regions for thousands of years as hunters of sea and land mammals and gatherers of shellfish and plants. Archaeological evidence indicates that the eastern Canadian Arctic was first inhabited between 2500 BC and 2000 BC by Arctic adapted peoples referred to as the Dorset culture (Maxwell 1984). Around 1000 BC, the Thule culture originating in Alaska, began to expand into the eastern Arctic. Archaeological models suggest that in addition to *in situ* cultural change, the Dorset population was largely replaced by the Thule, who are considered the ancestors of the modern Inuit (McGhee 1984). The shift is ascribed to the more sophisticated technology of the Thule peoples (presence of hunting dogs, bows and arrows, umiaks) who could operate in larger social groups because of their efficiency and ability to hunt large mammals such as the bowhead whale (Maxwell 1984, McGhee 1984). These two cultures adapted to a highly successful arctic diet based largely on animal food sources.

The marine environment has provided the majority of the traditional food of the Inuit, the ringed seal being the primary staple (Boas 1964 [1888]). Other species of importance in the Inuit diet are bearded seal, muskox, caribou, bowhead whale, beluga, narwhal, harp seal, fish and shellfish. Animal sources have contributed the majority of energy, protein and fat in the diet of the Inuit (Boas 1964 [1888], Hoygaard 1941, Mann *et al.* 1962, Kemp 1971, Draper 1977, Kuhnlein & Soueida 1992).

Plants appear to have always played a minor to a negligible role in the diet of the Inuit. (Boas 1964 [1888], Draper 1977, Stefansson 1960, Weyer 1932). The literature contains few references about the use of plants among Inuit of Baffin Island although some food plants were harvested and stored for winter use among groups of Inuit in

Labrador, Alaska, Siberia and Greenland (Porsild 1953, Eidlitz 1969, Hoygaard 1941). Plant use is more frequently identified as a starvation food or a treat in a diet dominated by animal sources, however, it has also been identified as a trade item (Eidlitz 1969, Hoygaard 1941, Warmow in Ross 1997). Schaefer and Steckle (1980) proposed that in the traditional diet, plants were more important than has been described in ethnographies.

In a diet composed mainly of animal sources, generally perceived as poor sources of vitamin C, the question arises with respect to the intake and sources of vitamin C in the Inuit traditional food system. Documents from the 18th and 19th century indicate that scurvy, caused by vitamin C deficiency, was not observed among the Inuit while often a serious illness for Arctic explorers (Berton 1988, Carpenter 1986, Weyer 1932). It has been assumed in the literature that the Inuit were able to obtain, from a diet of frozen/raw, fermented and dried animal food, a minimum level of vitamin C (10 mg/day) required to prevent scurvy (Carpenter 1986, Draper 1977, Sinclair 1969, Hoygaard 1941). Vitamin C deficiency, associated with an increased market diet, has been documented in Inuit of Greenland and the Canadian Arctic in the 20th century (Bjerregaard & Young 1998, Sabry *et al.* 1974). Historically, of more concern to the health of the Inuit were periods of starvation attributed to illness and/or unfavourable hunting conditions which resulted in lack of food and/or insufficient caches (Cowan 1977, Hanson 1941, Tagona 1977, Weyer 1932).

Published reports of values for concentrations of vitamin C in Inuit traditional foods are limited or contain questionable results due to analytical methods used and missing information as to species, sample size, storage methods and proximate composition values. There is a general need for better food composition data for non-cultivated food (Burlingame 2000) and specifically for vitamin C. Food composition data for uncultivated foods that are major contributors in the diet of specific populations would greatly improve dietary assessments of those populations (Kuhnlein *et al.* 1979).

It was the purpose of this thesis to determine vitamin C levels in traditional Inuit food items and to establish contemporary vitamin C intake through the application of these data to available dietary information for an Inuit community of Baffin Island. A third aspect

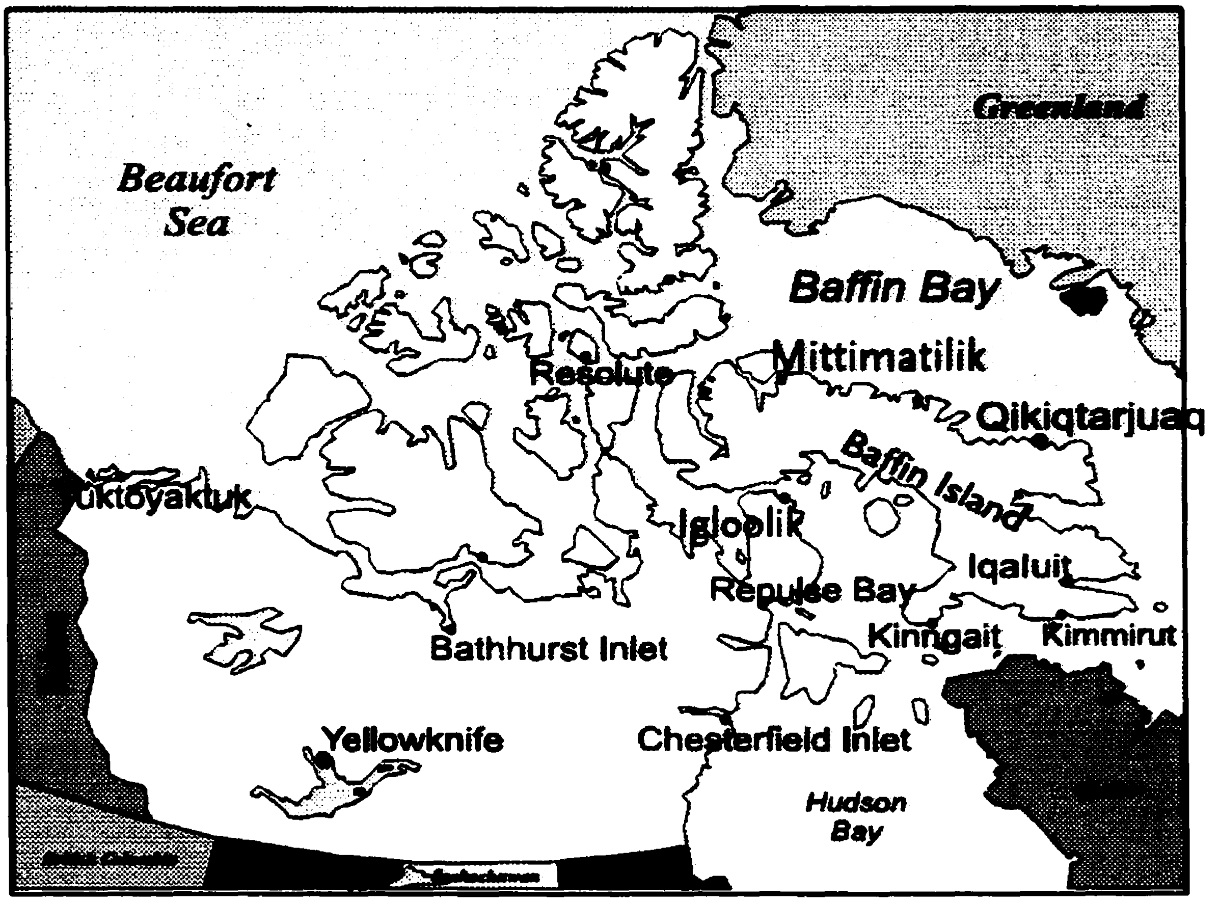


Figure 1.1 Canadian Inuit Areas North of 60°

of this thesis involved the estimation of a pre-contact intake of vitamin C using the analytical values from traditional food. Qualitative interviews conducted in a second Baffin Island community provide context to meanings and reasons for current food choices which may impact the intake of vitamin C. Qikiqtarjuaq and Mittimatilik were the two communities of focus in this thesis (Figure 1.1).

The results from this thesis contribute significantly to our understanding of the nutritive value of the Inuit traditional food system and the historical and contemporary sources and intake of vitamin C among Inuit. Food composition data and results presented here will be of valuable assistance in future dietary assessments of traditional food consumers.

2. Literature Review

2.1 Vitamin C

2.1.1 Vitamin C Adequacy

Considerable research has been conducted to clarify the biochemical functions of vitamin C in humans and animals. Deficiency of this vitamin results in scurvy which historically is considered to have had the greatest impact on human suffering as the result of a nutritional deficiency (Carpenter 1986). Scurvy emerged as a serious problem, in regards to loss of human life and the resulting cost to enterprises during the era of European exploration, particularly because of the long sea voyages which often forced long term exclusive reliance on dried and salted preserved food. Diverse theories about the cause and cure for scurvy were debated for hundreds of years before a definitive understanding was realized in the 20th century.

Scurvy frequented the ships travelling through the circumpolar region. It is hypothesized that starvation and scurvy were directly responsible for the loss of the crew under James Knight in 1719 and those employed aboard the Franklin expedition, last seen in 1847 (Neatby 1984). A vivid narrative from Munk, who lost 62 men to scurvy in Churchill, Manitoba over the winter of 1619-1620 describes the daily struggle for survival. Through the fall plants and game were obtained but in the winter wild plant food was unavailable and game became limited in part due to the decreased number of men who could hunt due to illness. Stefansson (1946) argues that the nutritional value of food available was further decreased by the practice of boiling. By June only Munk and two of his men were alive but weakened from vitamin C deficiency. He wrote "Later on, we crawled about everywhere near, wherever we saw the least green growing out of the ground, which we dug up and sucked the main root thereof" (Munk in Stefansson 1946:160). They gradually recovered by consumption of fresh plants and fish.

There were some early successful treatments which stemmed from explorers such as De Gama who in 1498 observed that consumption of fresh oranges reversed the symptoms of scurvy, although a method to prevent and treat the symptoms of scurvy was not ascribed to until well after James Lind's publication, "A Treatise of the Scurvy in

1753"(Carpenter 1986). The British Navy began to carry lemon juice onboard in the 19th century, but effectiveness is believed to have been curbed due to factors such as processing losses, initially low levels in fruits, inadequate dosage and/or refusal to ingest an unfamiliar substance (Carpenter 1986, Ross 1997). Other reasons and cures of scurvy were still advanced including salt in preserved food, low levels of exercise and hygiene and lack of fresh food (Carpenter 1986).

On commercial ships there was considerable variation in the simple availability of food items considered to prevent against scurvy as mandatory 'anti-scorbutics' did not exist (Ross 1997). Parry on his voyage the Arctic (1819) carried onboard various food items considered to have anti-scorbutic properties including lemon juice, herbs and seeds for growing salad greens on board, sauerkraut, vinegar, pickles, spruce extract, canned meat and soups and flour (Ross 1997). Others observed that scurvy did not appear to be a problem among the inhabitants of the Arctic. Whaling captain George Comer purchased a regular supply of fresh meat from the Inuit which he considered essential to preventing scurvy (Comer 1984). One ship forced to overwinter off the coast of Greenland survived on bear, deer and walrus meat obtained in the fall and 'moldy whale greaves', the remains of whale skin/blubber post oil extraction (Carpenter 1986).

Captain William Penny, instrumental in opening Cumberland Sound to whaling, had fresh root vegetables and herbs available on some trips (Ross 1997). Shortly after his arrival in Cumberland Sound in 1857, the crew was ordered to eat "crowberries" and blueberries and "a small sour plant" [likely sorrel], all of which he considered "excellent preventatives for scurvy" (Ross 1997:159). Margaret Penny, who accompanied her husband, noted in her journal entry of September 29th that she "ate a bit of the skin [whale] which is a preventative of scurvy" (Ross 1997:78). Ross suggests that this knowledge was gained in an earlier trip to Greenland in 1850 from which journey Penny's surgeon, Peter Sutherland, recorded that the narwhal "is highly prized by the Esquimaux as food, and by the Danes as an invaluable anti-scorbutic" (Sutherland 1852:223). Sixty years later Bertelsen, a Danish scientist, was to argue that ringed seal liver and whale skin were the most 'anti-scorbutic' animal foods (Hoygaard 1941, Carpenter 1986), although when scurvy occurred aboard another ship in the fall of 1857, carrots and potatoes were given as a treatment (Ross 1997).

Peter Freuchen, a Danish doctor and member of the 5th Thule expedition based at Melville Peninsula from 1919-1925, wrote in his notebooks that when a whale was brought to the beach at Repulse Bay everyone feasted on the skin until their jaws became too sore to continue. He speculated that the 'large quantities' eaten were due to its "excellent cure for scurvy and answers a simple craving of the system" (Freuchen 1935;422).

The perspective that food played a role as a cure and preventative of scurvy became part of the European belief system by the 19th century. In the Inuit traditional knowledge system food has medicinal roles but the role of food in the prevention of scurvy has not been documented. Whether Inuit had ever encountered scurvy other than as part of the symptoms resembling the process of starvation is unknown.

Brett, in his paper on the history of medicine in the north wrote,

"Instead of the European bringing medical attention to the Eskimo, the latter ministered to the explorer in matters of health by instructing him in the principles of Arctic survival and in preventing scurvy by the simple expedient of eating fresh raw meat..." (Brett 1969:522).

2.1.2 Function, Sources, Recommended Intakes

Vitamin C is biologically active in two forms, ascorbic acid (AA) and oxidized dehydroascorbic acid (DHAA). DHAA can be reduced to AA, but oxidation of DHAA to diketogulonic acid, an inactive form, is non-reversible. Vitamin C is an essential micronutrient for primates, bats, guinea pigs and some bird species in the Passerformes Order (Englard & Seifter 1986) due to the loss of the gene responsible for the synthesis of gulonolactone oxidase which is necessary in the conversion of glucose to ascorbic acid (Flodin 1999). This silencing of a gene is believed to have been lost from primates over 50 million years ago.

Vitamin C has a host of biologically important functions. It has a critical role as a reducing agent for many reactions including hydroxylation reactions in the formation of collagen. In the absence of adequate amounts of the active forms, symptoms of vitamin C deficiency will occur (Basu 1982, Englard & Seifter 1986, Jacob 1999). Vitamin C is considered the most effective antioxidant in the aqueous phase and can regenerate glutathione, vitamin E and flavonoids. It plays a role in formation of norephinephrine, corticosteroids, cholesterol degradation, carnitine biosynthesis and possibly the hydroxylation of tryptophan to serotonin (Jacob 1999, Halpner *et al.* 1998, Kitts 1997). It is absorbed in the distal portion of the small intestine. Absorption is 94 % on a diet containing 120 mg/day or less, decreasing to 16 % for intakes of 12 g (Sauberlich 1985 in Hunt & Groff 1990) .

In the western model of health and diet, people readily identify fruits and vegetables as natural sources of vitamin C. Most of the vitamin C in North American diets is provided by a few fruits and vegetables which include citrus fruits, green vegetables, potatoes and tomatoes (Jacob 1999). Meat products are not perceived or marketed as a source of vitamin C, perhaps due to the limited consumption of organ meats which may contain levels above 18 mg/100 g. According to Stefansson (1946), disbelief was the reaction of health professionals at John Hopkins to his recount of a year's survival in the Arctic on a meat-based diet, absent in fruit and vegetables. The physicians and nutritionists firmly believed that only fruit and vegetables could supply the anti-scorbutic properties of food (Stefansson 1946). Stefansson provided evidence that a diet containing fresh meat alone was sufficient to ward off scurvy. There have been no studies to my knowledge that have explored the potential adaptation of people of the circumpolar areas to a diet containing vitamin C at levels below those established for the general population based on kinetic studies in males.

Statistics from U.S. surveys indicate that over 20 % of adults consume a vitamin and/or mineral supplement daily, of which vitamin C is a common ingredient with a usual dosage of 60 mg/day (Johnston 1999). Low intakes and reserves of vitamin C may compromise health and increase susceptibility to disease (Basu 1982) but epidemiological evidence for the role of vitamin C in the prevention or treatment of diseases remains inconclusive (Jacob 1999). Links between a high vitamin C intake and a reduced risk of some cancers such as buccal, pharyngeal and esophageal have been described and low serum concentrations of vitamin C have been associated to higher blood pressure and cholesterol, increased risk of stroke, impaired wound and fracture healing, compromised antioxidant protection, anaemia, hemorrhage, easy bruising, joint pain, depression, gastrointestinal ulcers, premature birth and the premature rupture of fetal membranes (Basu 1982, Jacob 1999, Groff & Gropper 2000). AA also has been reported to counter some of the effects of heavy metal toxicity and reduce pain of people with osteoarthritis, bone metastases and Paget's disease (Jacob 1999).

Although 10 mg/day is adequate to prevent scurvy, recommended levels for daily intake have been set at least three times this level. Canada set the Recommended Nutrient Intake (RNI) levels for vitamin C at 2 standard deviations (SD's) above the average level of known requirement based on maintenance of a pool size of 900 mg, varying for age and gender categories (Scientific Review Committee 1990). The 1990 RNI was set at 40 mg/day for adult men and 30 mg/day for women, whereas the 1989 USA Recommended Dietary Allowance (RDA) was set at 60 mg/day for adults (National Research Council 1989). The World Health Organization (WHO) recommends 30 mg/day (Jacob 1999). Higher intakes of vitamin C (up to 200 mg/day) have been proposed due the role of vitamin C in countering oxidative stress and associations with reduction of risk for chronic diseases (Levine *et al.* 1996) yet there is no definitive evidence for established health benefits at higher doses (Jacob 1999). In April 2000, new dietary reference intakes (DRI's) were announced for vitamin C which are intended to replace the 1990 RNI and the 1989 RDA. For adult women, the estimated average requirement (EAR) is 60 mg/day which is the DRI to be used for assessment of group inadequacy of intake, 75 mg/day as the RDA for individual planning and 2g/day as the upper limit (UL). Values for women are based on extrapolation of results from studies of vitamin C requirements in males (IOM 2000).

The traditional food system of the Inuit appears to have supplied ample vitamin C in the diet to prevent overt symptoms of scurvy (Hoygaard 1941, Stefannsson 1946) although the potential usual range of intake is unknown. There is limited information as to usual and historic intake of vitamin C in the Inuit diet due to incomplete food composition values for traditional food and limited dietary intake data. These gaps in knowledge form the core of the research questions for this thesis.

2.1.3 Variability in Food

2.1.3.1 Biological, Environmental, Food Processing

Vitamin C levels in food vary considerably due to factors which include species, maturity, portion, soil, climate, season, diet, storage, handling, method of preparation and consumption (Pennington 1975). The extent of the natural variation of vitamin C in food and the effects due to processes from harvesting to consumption is unknown (Greenfield & Southgate 1992). Additionally, AA added at the manufacturing level to processed foods may be a major source of variation in some market foods.

AA is unstable in the presence of oxygen, metals (iron, copper), and enzymes. Storage at -18°C or lower can reduce losses to less than 10 - 20 % over a year for plant foods, however in animal foods that may initially have low concentrations, this may be on the magnitude of 50 % loss in 6 months (Kramer 1979, Erdman 1979). Storage at -80°C minimizes the loss of vitamin C.

2.1.3.2 Addition to Food

In Canada, the addition of AA and its synthetic form isoascorbic acid (IAA) is limited under a food and drug regulation. AA is restricted to food for the purposes of restoration of the original level before processing, storage and handling (ie. dehydrated potatoes, potato chips); for fortification purposes because of a previously demonstrated deficiency among a subset of the population or fear of (ie. flavoured bvg. mixes and bases for addition to milk, evaporated milk, evaporated skim milk, concentrated skim milk, evaporated partly skimmed milk, concentrated partly skimmed milk, evaporated goat's milk, evaporated partly skimmed goat's milk, evaporated skimmed goat's milk); for foods marketed as special purpose foods (ie. food for low-energy diet, meal replacements and nutritional supplements, formulated liquid diets); for substitute foods (ie. infant formula, fruit nectars, vegetable drinks, fruit-flavoured drinks, bases, concentrates and mixes for vegetable and fruit-flavoured drinks, apple, pineapple and grape juice, reconstituted apple, grape and pineapple juice, mixed fruit juice, concentrated fruit juice except frozen concentrated orange juice). Part D of the Food and Drug Regulations specifies minimum and maximum amounts of vitamin C that can be present in foods to which it is added. The addition of Isoascorbic acid (IAA), commonly used as a preservative in various foods and beverages is restricted. IAA has ~5 - 10 % of the activity of AA with respect to the antioxidant role of AA but it does not act as a reducing agent and therefore has no functional role in the normal development of cartilage, bone and dentine and prevention of scurvy (Jacob 1999).

It is mandatory to add AA to fruit flavoured drinks marketed as a substitute for fruit juice or as a breakfast drink (1978), meal replacements (1978), nutritional supplements (1995), ready breakfast cereals (1966), cow milk (1975) and goat milk (1985). All other additions are permitted (Health Canada 2000).

Studies carried out by Health Canada have found discrepancy between the amounts of AA and IAA added to foods and that which is listed on the labels (Behrens & Madère 1994, Hidiroglou *et al.* 1997). Levels have been found to exceed those allowed. Significant variation for vitamin C has been found in nutritional drinks, diet products, and beverages which seemed to be a result of manufacturing practices (Hidiroglou *et al.* 1997). While not considered likely to cause harm, one of the sources of error in the use of recalls and food composition tables lies in the fact that the amount generally ascribed to a product may be markedly different from the food that a consumer is eating because of a manufacturer's lack of quality control in the addition of vitamins.

2.1.4 Food Composition Variability and Effects on Computed Vitamin C Intake

Using vitamin C data from the USDA database, Beaton (1987) calculated that the range of coefficient of variation below a cut-off point of 7.5 mg/100 g is 5-50 % whereas above this cut-off point at higher concentrations, the range is smaller from 10-30 %. Pennington (1975) estimated that the coefficient of variation for vitamin C between natural food was 30 % (Pennington 1975). Beaton (1987) used USDA food composition data base to perform simulation computations on two model diets to assess the impact of food composition variation on a one day food record. He reported that variability had a smaller impact on computed nutrient intakes as the variety of foods increased, suggesting that the greatest improvement in estimation of nutrient intakes would occur if major contributors of dietary nutrients had accurate analytical values.

2.2 Traditional Diet of the Baffin Island Inuit

2.2.1 Area

For the purposes of this thesis, information on the traditional subsistence and diet patterns focuses on the Baffin Island Inuit, which include the Iglulik and Baffinland Inuit. As described by Kemp (1984) Baffinland Inuit territory encompasses the southern 2/3's of Baffin Island and Iglulik Inuit, the northern area of Baffin Island and down to Foxe Basin. These two 'regional groups' are part of the 'cultural groups' identified as the Central Eskimo (Inuit) group which also includes the Netsilik, Copper, and Caribou Inuit (Damas 1984). With the exception of the Caribou Inuit, sea mammals were hunted throughout the year among the Iglulik and Baffinland Inuit and during the winter by Copper and Netsilik Inuit. Land mammals were hunted in the late summer and fall by the Iglulik, Baffinland Inuit, Caribou Inuit and Copper and Netsilik groups.

The area around and including Qikiqtarjuaq on the south eastern side of Baffin Island was historically used by the Padlimiut. To the north were the Akudnirmiut and to the southwest on the south side of the Cumberland Peninsula and around Cumberland Sound were the Oqomiut (Boas 1964 [1888]). Boas speculated that the Padlimiut were a sub-group of the Akudnirmiut. Boas estimated that in 1883, there were 43 Padlimiut and 40 Akudnirmiut and considered that the small numbers were due to the diseases brought by the whalers and traders. Whaling on Davis Strait began in the mid 1700's and by 1850 contact between whalers and residents of Davis Strait and Cumberland Sound was established (Kemp 1984). Just north of Qikiqtarjuaq was an important trading area at Kivitoo, to which Akudnirmiut and Padlimiut would voyage every summer to meet the whaling ships on their journey southward (Boas 1964 [1888]) but no permanent whaling station was established. As whaling began to decline in 1870, fur trapping became important but not before 1960 did the Hudson Bay Company establish a trading post at Qikiqtarjuaq (Foote 1967, Kemp 1976, Kemp 1984).

2.2.2 Animals

Baffin Island Inuit harvested and still harvest a wide range of sea and land mammals, birds, fish and shellfish. These include *Phoca hispida* ringed seal (nettik), *Erignathus barbatus* bearded seal (ugjuk), *Phoca groenlandica* harp seal (qairulik), *Odobenus rosmarus* walrus (aivik), *Delphinapterus leucas* beluga (qilalugaq), *Monodon monoceros* narwhal (qilalugaq tuugaalik), *Ursus maritimus* polar bear (nanuq), *Rangifer tarandus spp.* caribou (tuktu), *Lepus arcticus* Arctic hare, *Alopex lagopus* Arctic fox, *Clangula hyemalis* Old-squaw duck, *Somateria spp.* eider duck, *Uria spp.* murre, *Melanitta spp.* scoter, *Lagopus spp.* ptarmigan, *Anser spp.*, *Chen caerulescens* and *Branta sp.* geese, *Salvelinus alpinus* arctic char (iqaluk), *Myoxocephalus spp.* sculpin, *Mya spp.* clams, *Mytilus edulis* mussels (Kuhnlein & Soueida 1992). *Balaena mysticetus* bowhead whale (arvik) were formerly pursued but commercial exploitation decimated the population with the result that hunts during the 20th century by the Inuit were rare. As the bowhead population appears to be increasing there is discussion of renewed hunting (Hay 1997).

2.2.2.1 Animal Parts Used

Animals and the parts used varies according to culture and needs, availability of resources, climate and time. From Qikiqtarjuaq, an extensive sample of Inuit traditional food in use in 1987 was collected for nutrient analysis (Kuhnlein & Soueida 1992). This included ringed seal meat, blubber, liver, flippers, heart, brain, eyes, intestine, ear, tongue, lungs, blood and stomach, bearded seal meat, blubber and intestines, narwhal and walrus meat, liver, heart, blubber, mattak, flippers and intestine, beluga meat, mattak, blubber and liver, polar bear meat and fat, caribou meat, brain, tongue, stomach contents and lining, heart, lungs, lips, cartilage, bone marrow and eyes, arctic char meat and skin, sculpin, halibut, cod and fish eggs, arctic tern eggs, seagull ptarmigan and various ducks and shellfish (Kuhnlein *et al.* 1989, Kuhnlein & Soueida 1992). Mattak refers to the epidermal, dermal and blubber layers of whales. Other common spellings are mattaq, maataq, maktak, muktuk and muktuq. In some instances, mattak is applied to walrus kauk (skin).

In the Inuit food system, most animal parts were historically used. The relative contribution of animals to the overall diet is subject to great variation between 'regional groups'. Boas (1964 [1888]) recorded that groups in Cumberland Sound in the early 1880's relied on boiled ringed seal and walrus meat as a winter staple, supplemented with organs and stored food if meat levels were low. Today, caribou and ringed seal (meat and broth) and whale mattak (skin) are the most frequently consumed traditional foods in the community of Qikiqtarjuaq (Kuhnlein & Soueida 1992). With respect to whales, Freeman (1970) noted among residents of Southampton Island that whale mattak was reserved for humans and whale meat was used in times of scarcity, otherwise the meat and organs were used as dog food. However, in Qikiqtarjuaq in 1987-1988, dried narwhal meat ranked within the top 20 foods used by women based on fresh weight but organs did not rank within the top 50 foods listed (Appendix A).

A resource harvest study conducted in Arviat, formerly Eskimo Point prepared by Quest Socio-Economic Consultants Inc.(Questcon) (1978) attributed reasons for a decrease in use of parts of marine mammals to processes of acculturation, resource depletion, availability of wage economy and market food and contaminant concerns. At the time of the Questcon study, beluga meat use had been discontinued due to mercury contamination. Acknowledging that there were large variations between regional groups, prior to market food and settlements, it is likely that a greater variety of animal parts were eaten more frequently in the past.

Variations also existed in local subsistence strategies. Among the Nunamiut in Alaska, hunting strategies and parts processed depended on such variables as temperature, distance from home, elder requests, available resources, season and absence/presence of pregnant woman (Binford 1974). Once food was obtained, distribution varied along social lines. As observed by Kemp (1971) and Borré (1991), on Baffin Island a freshly killed seal may still be divided on the basis of hunter/non-hunter or male/female. Borré (1991) described ringed seal food selection just after a hunt (in camp) among Clyde River Inuit who live on the eastern coast of Baffin Island. For a fresh killed seal the hunters would typically first eat some liver and blood, followed by a mixture of brain and fat with meat.

Women and children would first select intestine, a small bit of liver and some meat. Kemp (1971) described a similar community event when hunters returned with a freshly killed seal in a village near Lake Harbour, Baffin Island. The men would initially eat the liver and the women the heart, followed by portioning out specific parts of meat to women after which men would choose from the remains. After everyone had eaten their fill, the remainder of the seal would be divided and parts eaten would not be restricted to a specific sex.

In sum, the Inuit diet depended on consumption of a broad array of arctic fauna, which in general was maximally used for food purposes. There was, however, regional, local and socially prescribed variations in diet, reflecting variations in ecology, local conditions and cultural choices that are typical of a people widely distributed across a region and well adapted to local ecosystems.

2.2.4 Plants

"the most northerly tribes... the use of vegetable food is purely incidental and largely limited to the partly fermented and pre-digested content of the rumen of caribou and muskoxen, whereas in the diet of the Eskimo of the southwestern Greenland, Labrador, and western and southwestern Alaska, vegetable food constitutes a regular, if not very large, item" (Porsild 1953:16)

From this statement we are left with the impression that plant use among the Central and Eastern Arctic is negligible. There are few sources of information as to the historic and current roles of plants among Inuit, making it difficult to construct the actual place of plants in the diet for the present and the past. From his work among the Copper Inuit in the early part of this century, Stefansson (1971) recorded that plants were formerly viewed as starvation foods and their more frequent use is a result of contact with other groups. Porsild generalized about Inuit plant use that "crowberry [blackberry] *Empetrum nigrum* is the most frequently used and the other berries including mountain cranberry *Vaccinium vitis-idaea*, bilberry *Vaccinium uliginosum* are not frequently used except by Whites " (Porsild 1953).

Eidlitz (1969), compiled lists of plants used by circumpolar populations. From ethnographies of the 19th century, only algae and caribou stomach contents (lichen) were described as plant food used by Baffin Island Inuit. Hall (Hall 1865 in Eidlitz 1969) described algae as a starvation food among Inuit of Frobisher Bay whereas Payne (Payne 1889 in Eidlitz 1969) wrote that it was a common winter food for groups inhabiting the coast of Hudson Strait. Whether Payne's observation were during a winter when supplies were limited is unknown. Algae was recorded as a trade item among groups, although groups would not necessarily meet to trade on a regular basis. Among Qikiqtarjuaq residents in 1987-88, Kuhnlein (personal communication) noted that kelp was a common traditional food and often seen drying in homes. Borré (1994) described algae as an item that Clyde River Inuit collected during the summer months. Boas claimed that the primary source of vegetable matter in the diet of southern Baffin Island Inuit were the stomach contents of caribou. Roots and berries were and are still collected in the summer on Baffin Island (Sabo 1981, Kemp 1984) but quantities harvested are unknown.

Plants collected on Baffin Island include *Oxyria digyna* mountain sorrel (kunguliq), *Epilobium latifolium* broad leaf willow herb or Arctic fireweed (paongaq), *Empetrum nigrum* blackberry/crowberry (paonaqnaq), *Vaccinium uliginosum* blueberry (klgutagingqaq) and leaves (naqinaq), *Polygonum viviparum* bistort or knotweed (tukslaq), and *Pedicularis hirsuta or Pedicularis lanata* hairy lousewort and wooly lousewort (ojunaq), *Salix reticulata* netted willow (kaoraq), *Salix arctica* arctic willow (okaraq), *Saxifraga tricuspidata* prickly saxifrage, and *Pyrola grandiflora* wintergreen (aluqsiaq). Various forms of seaweed including *Rhodymenia palmata*, *Alaria spp*. and *Laminaria spp*. are also collected (Kuhnlein & Soueida 1992, Borré 1994).

In terms of usual food preparation, plants were consumed raw or boiled. An elder named Apphia Awa from Mittimatilik recorded from her memories of living on the land (prior to settlement) that plants such as blueberries and their leaves, blackberries or grass were picked and eaten while walking and that during the summer caribou fat was often mixed with blueberries or blackberries (Wachowich 1999). A common use of plants in many cultures is as a beverage such as tea but this use among Baffin Island Inuit may have its origins in the post-contact period. Apphia Awa recorded that tea was unknown in her family before its introduction by whalers and that she herself did not drink tea from gathered plant leaves or the market prior to her marriage (Wachowich 1999).

In a study of plant use among Inuit residents of Clyde River, gathering methods and significance in subsistence were related to group (prior to settlement) differences in patterns of hunting, dwellings or division of labour (Borré 1994). Plants harvested were primarily shared among elders, children and woman friends. With respect to the importance of plants in Inuit subsistence, Borré (1994:10) noted that "women also cautioned me that in the past plants had been very important to their survival, but store bought goods and replaced the need for plants for a long time and people had begun to forget about plants".

2.2.5 Seasonal Variation in Traditional Food Sources

"January is the time for light. February is the time for bright. Animals deliver in March, and April is the month of baby seals. July is for calves of caribou, they start delivering in July. August is the middle of the year and September, halfway through the year. October and November are fall. November is for hard times and December is the dark season. That is how the year was described" (Apphia Awa in Wachowich 1999:32)

One can demonstrate the seasonal variation in traditional food sources according to quantitative nutrition surveys that take place over a calendar year. As I would like to provide the reader with an understanding of the extent of seasonal variation in reliance on various Arctic fauna historically and presently, it is useful to present a description of the seasonal hunting as observed by ethnographers. While these practices are variable according to local and regional subsistence strategies, the ethnographic descriptions show a general pattern of food acquisition, where different foods are obtained when Inuit local groups move to areas where there is local seasonal availability or abundance. A more specific model of this general pattern is described below.

On Baffin Island, from March onwards there was a notable increase in food availability (quantity and variety) until after the freeze-up in fall when episodes of hunting, dependent in part on levels of food stores acquired in early fall, became limited to the pursuit of the ringed seal at breathing holes on the land-fast ice (Boas 1964 [1888]). Animal distribution and hunting were and are principally affected by the climate, ice formation, season and sea winds (Boas 1964 [1888], Stevenson 1997).

In the early spring (March), the larger winter village that had aggregated together in the early fall would break apart into smaller nomadic camps that would pursue young seals. By June, some Inuit would move near to the heads of fiords to catch arctic char on their descent to the sea. Beluga and narwhal were hunted from June until the formation of ice in the fall (October). Whales were butchered near the harvest site and the parts desired were removed to the main settlements by a few members of the group while the rest continued hunting (Boas 1964 [1888]). Walruses were also found close to shore in the spring and summer (Kemp1984).

In summer, many of the younger people would move inland to pursue caribou for winter clothes and meat while others remained at the coast to pursue the ringed seal, bearded seal, beluga, narwhal, harp seal and birds and walrus which arrive with the break up of the ice (Sabo 1981, Wachowich 1999). Some of the marine mammals pursued in summer would be cached for dog food as the warmer temperatures spoiled the meat (Freeman 1970). Plants and shellfish would be harvested until freeze-up (Sabo 1981). On Davis Strait, areas for hunting ducks and their eggs were limited but in July eider ducks appeared and were caught at the head of one fiord (Boas 1964 [1888]). For Cumberland Sound residents, bird nesting areas were more abundant and were regularly visited until freeze-up (Boas 1964 [1888]). In August, the Padlimut (eastern Baffin Island) would travel to Qivitung (Kivitoo in Kemp 1984) to trade with the whalers and some would move to Qikiqtarjuaq after freeze-up where they might remain until the end of spring (Boas 1964 [1888]). Others moved further south to pursue polar bears during the spring and later arctic char in the summer. By September, people would usually settle in small villages of 18 - 40 people with perhaps double the number of dogs, along the coast near hunting areas (Kemp 1971). Group fall hunts of the larger marine mammals (whales and walrus) would take place for a few weeks until they retreated from the coast with the coming of ice (Kemp 1971, Kemp 1984). These fall hunts were critical periods for laying in adequate stores for winter food (Kemp 1984). After freeze-up, the hunters would begin to travel on the land-fast ice to the floe edge in pursuit of the seal. Villages could be temporarily relocated further onto the ice to pursue ringed seal (Sabo 1981). In late winter (February/March), some hunters might voyage inland to hunt caribou and fish for arctic char in the frozen lakes.

Shortage of food could occur due to poor weather conditions and illness among people at camp or the dogs, either of which could severely impact hunting and cause starvation, not because of the lack of game (Boas 1964 [1888]). If possible, dogs would be killed and eaten but this would further contribute to poor hunting as they were considered invaluable for finding breathing holes in the winter. These examples of seasonal variation in the availability of food indicate how consumption patterns change depending on the time of year and location of any particular individual. Though starvation was an occasional problem fresh food, largely sea mammals, was available year round.

2.2.6 Changes in Lifestyle and Traditional Food Use

Inuit of Baffin Island have been largely sea mammal hunters. With the advent of the whaling industry and continued contact with Europeans and its resulting change in Inuit hunting and lifestyle, traditional food used by the Inuit has changed in terms of quantity and relative importance of various species, types of food used (parts, raw, cooked, fermented), daily and seasonal use. Quantifiable data are absent prior to the dietary surveys conducted in the latter half of this century, although there have been estimates of macronutrient ratios and estimated total food weight based on observational and limited weighing data. Most of the early ethnographic sources give no concrete data on relative consumption of traditional food, instead being limited to descriptions of the major species used.

Ringed seals were the primary food of the Baffin Island Inuit pursued year round (Boas 1964 [1888]). It was the main source of winter food and continued as the most important staple of the Inuit of Baffin Island (Kemp 1984). Historically, caribou and char had a smaller role in the Inuit diet and were pursued primarily from late summer (August) into the fall, the caribou for their hides for winter clothing and Arctic char for winter stores, dog food and a change in the diet (Stevenson 1997). After the introduction of firearms, caribou could be more easily hunted year round (Boas 1964 [1888]) and became an important supplementary food source throughout the winter for its meat (Stevenson 1997). The caribou herds are, however, more fragile than the staple ringed seal as evidenced by the rise and fall in caribou numbers. From the 1930's to the 1970's no caribou were hunted in Pangnirtung Fiord (Stevenson 1997), making the diets of the Inuit living in this region quite different than their contemporaries in other parts of the Arctic.

Bowhead whaling was pursued prior to the whaling period in kayaks and skin boats among the residents of Cumberland Sound. Captain Penny, credited with opening up Cumberland Sound to the whaling industry after his guide Eenoolooapik revealed the Sound's abundance of whales, wrote that the Sound's inhabitants appeared to take 8-12 whales per year (Stevenson 1997). Eenoolooapik indicated that the bowhead flesh [skin?] was the staple in the diet of groups who inhabited the Sound (Stevenson 1997). Boas indicated that a noticeable decrease in the food supply among the Inuit of Cumberland Sound occurred due to their abandonment of whaling in the face of the presence of European and American whalers, but he doubted that whaling alone in the fall had ever been adequate to support the entire winter needs of a population he estimated at 1600 prior to the whalers's presence (Boas 1964 [1888]). Whale meat among many groups seems to have been formerly used for dog food but the whale mattak has always been a favourite traditional food of the Inuit (Freeman 1970, Kilabuk 1998). Formerly walrus appear to have been a more important staple (Stevenson 1997). From spring into early fall, birds, ducks, shellfish, arctic hare, other fish (sculpin) were also harvested but by weight appeared to have contributed less than 5 % to the overall diet (Hoygaard 1941, Kemp 1971).

Contact with arctic explorers and whalers in the early 19th century brought substantive changes. Former cooking pots of steatite were replaced with copper. To the diet were introduced pilot biscuits, flour, sugar and salt. By the late 1840's, Inuit of Cumberland Sound were involved in whaling and in exchange received guns, ammunition, used whaleboats, whale meat and skin (Tyson 1985), although the overall amount of whale in the diet of the Inuit decreased (Boas 1964 [1888]). The whale population in Cumberland Sound was decimated by the 1870's and the Inuit population became more nomadic, returning to the whaling stations to trade in the spring after sealing and in the fall after hunting caribou (Stevenson 1997). According to Boas, at the whaling station "every Saturday, the women come into the house of the station... to receive their bread, coffee, sirup and tobacco" (Boas 1964:59 [1888]).

For most of the 20th century the food of the Inuit remained largely 'country' or traditional, although flour and tea were obtained regularly by the Inuit in exchange for fox and seal furs. How much alteration in the relative importance of species due to trapping rather than subsistence hunting is not clear. Trading posts increased the variety of foods available, such as canned tins of meat and fish, jellies, marmalades, fruits and vegetables (White 1977 in Borré 1991) but their actual use and significance in the diet was not quantified. A decline in the fur economy between the 1930's and 1950's, resulted in ammunition and market goods shortages (Kemp 1984). The establishment of the Federal Family Allowance payments in 1945 increased the contribution of southern food to the diet for families with children under 16, payment for each child being given as trade goods (Wachowich 1999).

The greatest change in traditional food use was a result of the move to settlements, which started in 1955, and the subsequent demand by the Canadian government to put children into schools. For those who refused to send their children to school, Family Allowances were cut off (Wachowich 1999). Inuit people moved into permanent settlements and some became involved in the wage economy and hunting became a part time pursuit. In the late 1960's, dogteams were largely abandoned and replaced with the snowmobile. The Inuit purchased outboard motors and freighter canoes (Stevenson 1997). These items had to be purchased with money made in the wage economy, locking people into a different mode of production than the arctic adaptations of the previous generations. A greater concentration of people in one area created increased competition on the area resources (Stevenson 1997). Snowmobiles allowed hunters to travel further distances quickly in pursuit of disappearing game as well as eliminate the need for dog food, but costs of fuel and repairs are only possible in an economy where hunting is not expensive and/or one has an adequate income. Decline in income obtained for trapping and sealskins made hunting relatively more costly. Children were and are often sent away to more southern settlements for high school, which has further dislocated local family groups from their traditional hunting areas. These factors led to acculturation to a settlement lifestyle and have profoundly altered food consumption patterns in a few short decades. By the 1980's, store foods contributed to the bulk of the diet with higher levels of sugar consumption than in the south (Schaefer & Steckle 1980). Today, the Inuit diet is very mixed. Results from a dietary study in Qikiqtarjuaq, conducted during 1987-1988 indicate that traditional food accounts for 33 % of total energy intake (Kuhnlein *et al.* 1995). Today, traditional food retains its central importance with respect to Inuit culture and identity and nutritional importance to the Inuit of Baffin Island with significant variation between younger and older age groups.

2.2.7 Dietary Assessments of Canadian Inuit

The diet of the Alaskan Eskimos has been studied extensively but far less has been documented for Canadian Inuit. Of the Canadian surveys (summarized below) the general pattern of the early data is that some individuals were at risk for vitamin C deficiency. Later studies indicated that through fortification of market food, vitamin C intakes have increased beyond the minimal requirements to prevent scurvy. Nutrition studies in Inuit communities have been infrequent and seldom accounted for variation across seasons and time. Estimation of dietary intake of vitamin C has been hampered by the lack of values for traditional food.

The Nutrition Canada National Survey conducted in the early 1970's included Inuit from four Central Arctic communities. Inuit were individually interviewed on one occasion with a response rate of 60 %. Plasma results indicated that 20 % of children and adolescents and greater than 50 % of adults were at high risk for vitamin C deficiency with many exhibiting signs suggestive of scurvy (Sabry *et al.* 1974). At this time in the general Canadian population about 10 % of adults were considered at high risk. Plasma drawn from residents of Arctic Bay and Nanisivik in 1976, 1978 and 1980, indicated that only 6 % of the population were at 'high' risk (serum vitamin C <0.2 mg/100 ml) with no one under the age of 23 having low serum vitamin C (Verdier *et al.* 1987). Older people were at moderate risk with median values below 1.0 mg/100 ml for males over 40 and 2.0 mg/100 ml for females over 40 (Schaefer & Steckle 1980, Verdier *et al.* 1987). Kuhnlein's later study in Qikiqtarjuaq (Broughton Island), which collected data over the entire calendar year did not report group intakes for vitamin C because of the limited data on vitamin C values for traditional food (Kuhnlein 1989).

A recent preliminary assessment of the diet among Belcher Island, Quebec, Inuit (Wein *et al.* 1998) included information on frequency of foods consumed during two seasons and vitamin C intake. Twelve people from each age group were selected for participation. The study indicated that the median vitamin C intake of women aged 19 - 49 was 51 mg/day and of women over 50 was 21mg/day. Two recalls were obtained from each woman in reporting periods of Feb/March and October/November. For men aged 19 - 49 and over 50, the median intake of vitamin C was 31 and 8 mg/day respectively. Overall, a mean intake of 37 mg of vitamin C among the adults was reported. They attributed 27 % of the vitamin C intake to traditional food sources, although the authors cautioned that this value needed to be interpreted cautiously due to the limited laboratory data for vitamin C levels in traditional food. Lawn *et al.* (1998) reported results from nutrition surveys conducted in 6 communities on Baffin Island during the first 2 weeks in April or May 1992 and the last 2 weeks in March or April 1993. Each community was only surveyed in one period with the exception of Pond Inlet which repeated the survey. One 24-hour recall and a food frequency questionnaire were completed by women between the ages of 15 - 44. In total there were 688 interviews, including 60 pregnant and 110 lactating women. From 70 - 88 % of the women were smokers. Mean intakes of vitamin C were reported, with a range from 49.8 mg in Repulse Bay (n=62) to 161.8 mg in Gjoa Haven (n=121). No median values were reported nor the percentage of women meeting the RNI. The authors stated that the sources of vitamin C were market food, with "non-perishable foods" being the main vitamin C contributor.

2.2.8 Published Values of Vitamin C in Inuit Traditional Food

Part of the difficulty in assessment of vitamin C intake of Inuit has been the inadequate data for vitamin C levels in traditional Inuit food. Data are limited or nonexistent for vitamin C levels in traditional Inuit food. Acquirement of food composition data for uncultivated food has been identified as an important area of work to be done (Greenfield & Southgate 1992; Burlingame 2000). Analyses of these foods would assist in nutrient evaluations of populations using them (Kuhnlein *et al.* 1979).

Previously published works containing vitamin C values for traditional food were examined. Values for selected traditional food are summarized in Table 2.1 below. Among foods used and between samples there are significant variations in vitamin C levels. This can be attributed in part to biological variation, differences in storage and methods used.

Previous analyses appear to have been carried out on a single sample of $n = 1$. The methods used include titration with 2,6-dichlorophenol-indophenol (Hoygaard & Rasmussen 1939, Hoygaard 1941, Farmer 1970, Farmer 1971, Hjarde 1952, Hoffman 1967, Rodahl 1949) and determination of vitamin C with the derivative of 2,4-dinitrophenylhydrazine (DNPH) (Mann *et al.* 1962, Geraci 1979). These methods are known to be subject to interferences, lack specificity for vitamin C and have low sensitivity. There is no generally no information given as to sample storage and preparation. In some studies, samples were freeze-dried prior to extraction of vitamin C (Farmer 1970, Farmer 1971, Hoppner *et al.* 1978), a process known to destroy vitamin C.

2.3 Methods

A central contribution of this thesis is to establish vitamin C values for selected traditional Inuit food using current analytical techniques which are sensitive, reliable and reproducible. The analytical values will be applied in the dietary analysis of contemporary intake of vitamin C from traditional food using previously collected 24- hour recalls and in calculations of a pre-contact diet. The 24-hour recall method is commonly used to obtain reliable, quantifiable data with respect to nutrient intake for a population.

Table 2.1 Reported Vitamin C In Traditional Inuit Food (mg/100 g) Fresh wt.[a]

Common Name	Part & Preparation	Vitamin C (mg/100 g)	References[b]
PLANTS			
Cranberries	berry, raw	17 - 22, 108	3,4,5,7
Blackberries	berry, raw	9 - 51	1,5,8,13
Mountain Sorrel	plant, raw	9 - 95	1,3,8
Kelp (*Fucus spp.*)	raw	9 - 13	1,3
Kelp (*Laminaria spp.*)	raw	50	6
MAMMALS			
Ringed seal	liver, raw	7 - 35	2,9,11,12
Ringed seal	meat, raw	0.52 - 4	2,4,7,9,10,11
Ringed seal	meat, boiled	0.47	10
Bearded seal	intestines, boiled	0.9	11
Bearded seal	meat, raw	0.5 - 1	2,4,11
Beluga	mattak, raw	2 - 25	4,7,11,12
Beluga	meat, raw	0.5 - 3	4,9,11
Beluga	meat, dried	<1	4
Narwhal	mattak, raw	20 - 32	1,2,4,12
Narwhal	mattak, aged	0.6	1
Walrus	meat, raw	1 - 3	4,9
Caribou	meat, raw	0.76 - 3	7,9,10,11
FISH			
Arctic char	meat, raw	0.48	10
Cisco	roe, raw	7	7
BIRD			
Ptarmigan	meat, raw	<2	4

[a] values are obtained from foods harvested throughout the circumpolar region by the various authors and appear (notation) as in the original tables

[b] (1) Hoygaard, 1941; (2) Rodahl, 1949; (3) Rodahl,1952; (4) Hjarde, 1952 (5) Brown, 1954; (6) Heller & Scott, 1961; (7) Mann *et al.*, 1962; (8) Hoffman *et al.*, 1967; (9) Farmer *et al.*, 1971; (10) Hoppner *et al.*, 1978; (11) Geraci & Smith, 1979; (12) Helms, 1985; (13) Kuhnlein, 1989

2.3.1 Determination of Vitamin C Concentrations in Food

There are many assays to measure vitamin C in various biological tissues, however, many lack adequate sensitivity, specificity, stability and/or suffer from interferences. In biological samples, HPLC methods are considered to be very sensitive and offer the best determination (Washko *et al.* 1992, Finglas 1995).

Due to oxidation, it is recommended to store samples, if immediate determination cannot occur, at -80°C under nitrogen (Augustin *et al.* 1985, Washko *et al.* 1992). The sample is homogenized in a cold 3 - 6 % aqueous solution of de-oxygenated metaphosphoric acid to limit degradation by oxygen, heat, metals and enzymes during extraction of vitamin C. Cold metaphosphoric acid is considered the most effective agent in stabilization of the biologically active forms of vitamin C and denaturation of proteins (Augustin *et al.* 1985, Ball 1994). To minimize any effects of the introduction of heat, samples are usually kept in an ice bath during homogenization (Behrens & Madère 1994).

Methods available to determine vitamin C are titration with 2,6-dichlorophenol-indophenol, determination as the 2,4-dinitro-phenylhydrazine (DNPH) derivative, fluorometric and HPLC methods. Titration with 2,6-dichlorophenol-indophenol is subject to many interferences, is not specific for vitamin C, and can only determine AA, with a limit of detection at 34 nmol (Washko *et al.* 1992). The 2,4-DNPH method can measure both AA and DHAA. The assay is time consuming and not specific for AA and is subject to error due to the many reaction steps including interferences from sugars or sugar degradation products, which although lowered by dilution, cause a decrease in sensitivity (Cooke & Moxon 1981, Washko *et al.* 1992). Fluorometric methods are more sensitive than the previous methods but may falsely elevate the value for DHAA and falsely lower the value for AA (Washko *et al.* 1992).

HPLC methods have been developed that report either Total Ascorbic Acid (TAA) or determine AA and DHAA. Detection systems in use are fluorescence, UV or electrochemical. The most recent form of detection is electrochemical detection for vitamin C which is highly selective and sensitive with a limit of detection of 0.5 ng/20 μl or 0.2 mg/100 g of sample (Behrens & Madère 1994). AA is measured directly and TAA is measured after reduction of DHAA by DL-homocysteine. DHAA is measured by subtraction of AA from TAA.

2.3.1 Determination of Moisture in Food

Moisture analysis is commonly carried out in any food composition investigation for the purposes of determining the concentration of nutrients in a food, quality control and product development (Pomeranz *et al.* 1987). Only an approximate quantitative moisture content can be known due to variation of amounts of water in samples, change in moisture during sample handling prior to analysis, the nature of water in food, limitations of the methods and sources of errors. Methods used include drying, distillation, physical and chemical assays (Pomeranz *et al.* 1987). The vacuum oven and distillation methods are commonly used in food science investigations because of their convenience. Freeze-drying is often used in the research laboratory setting as it greatly reduces the loss of other compounds volatile at higher temperatures. This method removes water from samples by drying under a vacuum at temperatures below the freezing point of water.

2.3.2 The 24-hour Recall As A Dietary Assessment Method

The 24-hour recall is used commonly as an assessment tool in population studies. The interviewee is asked to describe all food and beverages taken in the past 24 hours with estimates of portions. To assist the interviewee and potentially decrease error of portion estimation, use of food models, photographs or household measuring tools are employed. This dietary method is fairly simple and quick. There is little burden on the subjects, memory problems are considered minimal and it has little effect on changes in behaviour (Hankin 1992).

For groups, the 24-hour recall is comparable to other methods (Beaton *et al.* 1983). If single recalls are used, the number of subjects required to estimate the group average usual intake is large (Gibson 1990). The primary limitation of this method is the intra-individual and inter-individual variability in food and nutrient intakes (Hankin 1992). A single day cannot estimate an individual's usual intake nor describe well the distribution of usual intakes of a population (Beaton *et al.* 1979). An increase in the reliability of the estimate can be obtained by increasing the number of observations. The sample size required is dependent on the degree of precision needed and the inter-individual and intra-individual variability which are dependent on the characteristics of the sample population and the nutrient intake being estimated (Gibson 1990).

2.3.3 Qualitative Interview Technique

Qualitative techniques are valid to gain perspectives on the various meanings of food between and within cultures. A variety of techniques may be used including focus groups, pile sorts, highly structured interviews to open - ended discussions around a few key concepts. Information from qualitative data can aid the researcher in various aspects of dietary studies such as research design, data collection and analysis, development of nutrition education materials and understanding other cultural concepts of food.

3. Communities of Focus

3.1 Qikiqtarjuaq

Qikiqtarjuaq is located ~ 1.5 km off the south east coast of Baffin Island. The Inuktitut name translates as "big island". It is 513 km north from Iqaluit and about 96 km inside the Arctic Circle. The settlement was created out of the construction of the DEW-Line site in 1956-57. Its construction drew people living in camps and from nearby areas of Kivitoo, Clyde River, and Pangnirtung. The school and the HBC post began in 1960 (Kemp 1976, Kemp 1984). By 1966, the number of residents was 209 and 117 dogs (Foote 1967). The population is currently estimated at 508 residents. Figures from Statistics Canada indicated in 1996 that there was 488 people, 470 of whom were Inuit (250 males, 220 females). The average age of the population is 24.6 with n=200 for adults aged 20 - 60 years.

3.1.1 Population Data

During 1987-1988, a study to evaluate the nutritional and toxicological components of the Inuit diet was conducted in Qikiqtarjuaq. This community was selected to represent Baffin Island Inuit communities because it was considered typical and data from harvest studies (1983-84), indicated high use of traditional wildlife food species per person (Kuhnlein *et al.* 1995). The profile of the community at that time was similar to current statistics. From July 1987 to May 1988, 24-hour recall interviews of individuals were conducted in bimonthly periods to represent the entire year (Kuhnlein 1989, Kuhnlein *et al.* 1995). Response was 60 - 70 % per survey period and non-response bias was controlled for (Kuhnlein *et al.* 1996). Participants included 91 adult women (>20, nonpregnant or lactating), 89 adult men (age >20) and ~169 children and youths (ages 3 - 19). For the purposes of this thesis, the focus was limited to women aged 20 - 40 years of age. The rationale for limiting the analysis to this subset of data is the recognition that females in their childbearing years have been identified at high risk for nutritional deficiencies and their health can impact their infants. As well, this subset is a socially important group, being often recognized in various cultures as responsible for food choices of children and other male members of the community.

3.2 Mittimatilik

Mittimatilik (Pond Inlet) is located on the northeastern tip of Baffin Island at Eclipse Sound within the traditional territory of the Tununirmiut (Matthiasson 1992). The area is considered the 'cultural heart' of the regional territory of the Igloolik Inuit which is composed of 5 groups (Brody 1976). There is a long history of relations and trading between the Igloolik and other groups such as the Scottish whalers who sought out the bowhead in the 19th century. By 1905 there was an established trading post in the area. In 1963, the Tununirusirmiut were made up of ~280 people, living in 7 camps and the settlement at Mittimatilik. Families lived primarily in camps until the early 1960's. The current population of Mittimatilik is 1154 from the 1996 census. Inuit comprise 85% of the population. There are 575 males and 505 females. Average age is 21 with an n=500 of people aged 20 - 60 years. This community was selected for qualitative interviews based on discussions with researchers.

II. PURPOSE

4. Rationale

Values for vitamin C levels in Inuit food and intake data are limited. Results obtained from the analyses of concentrations of vitamin C in traditional foods provide us with valuable new data regarding the nutritive value of traditional food. As stated previously, knowledge of the nutrient composition for food which is an important part of the diet of a specific population increases the reliability of the estimation of nutrient intake for that population. The vitamin C results are valuable for current assessment of adequacy of vitamin C intake and in future dietary surveys of populations who use these foods. These results are also valuable for nutrition education materials such as the northern food guides which aim to promote the nutritional benefits of traditional food.

It is recognized that vitamin C plays an important role as an antioxidant in the human body and current recommendations suggest intakes of vitamin C in excess of 75 mg/day among women aged 20 - 40 years. Studies in the early 1970s indicated that a large part of the population was at risk for vitamin C deficiency. Chronic low levels of intake of this vitamin increase short and long term health risks. In the late 1970s, due to the previously observed indications of a nutrient deficiency in a specific population, legislation was introduced which included the mandatory addition of vitamin C to specific market foods available to the Canadian public. More recent analysis of the intake of this important antioxidant and the relative contribution from traditional and market foods and supplements is limited for the Canadian Inuit population. A Health Canada survey conducted in the early 1990s during one season among Baffin Island communities indicated that the mean intake of vitamin C among female residents was greater than the RNI of 30 mg/day (Lawn *et al.* 1996). The study indicated that primary sources of vitamin C were from market food. There was no indication of the amount of vitamin C from traditional food.

The intake of vitamin C among women aged 20 - 40 years was estimated using the Qikiqtarjuaq dietary data set. Analysis of this data set for vitamin C intake provided relevant information on contribution of vitamin C from traditional food and market food, the occurrence of seasonal variation in vitamin C intake and a breakdown of the percentage of women aged 20-40 years who obtained in each recall period an adequate intake of vitamin C as determined by the RNI and DRI.

From an historical perspective, understanding of the long term historical adaptation of this population to the Arctic environment is limited with respect to vitamin C intake. In the early days of exploration and whaling, voyagers to the Arctic suffered from scurvy though this was not observed among the Inuit until traditional food was replaced by market food (Brett 1969, Bjerregaard & Young 1998).

5. Objectives

The objectives of this thesis were to 1) determine the levels of vitamin C in traditional food ; 2) evaluate and describe the contemporary intake of vitamin C in the diets of women 20 - 40 years of age; 3) estimate the historical intake of vitamin C from diets containing traditional food; 4) conduct qualitative interviews among Inuit to contextualize Inuit views on food and vitamin C.

III. METHODS

6. Description of Study

Inuit food samples were collected from Mittimatilik and several other Inuit communities. Vitamin C levels for traditional foods that are major contributors and/or historically of interest were determined. This thesis used available data obtained from a 1987-88 survey in Qikiqtarjuaq to estimate intakes of vitamin C from traditional and market (natural, fortified, supplements) sources for Inuit women aged 20-40 years of age (*n*=209 recalls). The University of California at Berkely (UCB) Mini-list (Murphy & Gross 1987) which contains nutrient values for market food was adjusted to reflect Canadian fortification levels. Analyses of dietary data were performed using Statistical Analysis System (SAS) for Windows, Version 6.12 (SAS Institute Inc., NC, 1999) software. Qualitative interviews were undertaken to gather Inuit perspectives on traditional food and health and vitamin C. Pre-contact intakes of vitamin C were calculated based on constructions of diet from various sources.

7. Sample Collection

Traditional food samples were collected in twelve Inuit communities in the Canadian Arctic and Labrador during the months of September to November 1998 and February to April 1999 as part of a larger project "Assessment of Dietary Benefits: Risks In Inuit Communities" directed by Dr. Harriet V. Kuhnlein (CINE, McGill University). Selection of traditional food for collection were based on information from the dietary survey conducted in Qikiqtarjuaq in 1987- 1988, workshops conducted during 1997 which included representatives from 38 Inuit communities and food frequency data from Inuit in Fall 1998.

8. Analysis of Traditional Food for Vitamin C and Moisture.

8.1 Decision Process on Foods to Analyse

Given the limited values and confidence in previously published values of vitamin C in Inuit traditional food (Appendix B), it was decided that analyses should be conducted on collected traditional food items. Food for analysis was selected on the basis of sample availability which was dependent on periods of collection, season and abundance in the various Inuit communities.

8.2 Food Sampling Strategy

Samples for analyses collected in the Fall 1998 and Winter 1999 were reviewed and prioritized into three categories for analysis: 1)high use or probable high vitamin C content and limited available knowledge; 2) historical use, minor use today and limited knowledge; 3) low use and suspected fair to good content.

Samples collected in the Fall of 1998 were prioritized for analysis and portioned in December and early January 1999. Moisture analysis was completed by January and vitamin C analysis was completed by February 1999 at the Nutrition Division of Health Canada (Ottawa), under the supervision of Dr. Nick Hidiroglou and technician Rene Madère. Samples collected in Spring 1999 were subsequently catalogued and stored in the same manner prior to analyses. Moisture analysis was completed by August 1999 and vitamin C analysis was conducted in June 1999.

The number of replicates was set at a sample size of n=3 to be taken from at least 2 geographic locations. It is recognized that a sample size of ≥ 10 would have been preferable (Greenfield & Southgate 1992) to estimate the variability among samples arising from biological variation, seasonal variation, freshness and storage/handling. The number of individual samples were constrained by seasonal and food availability in communities, periods of data collection and cost. The profile of samples collected (community, sample size, harvesting date) is contained in Appendix C.

8.3 Sample Size, Portioning, Preparation

Samples were collected from the field with target weights of 500 g. In some cases, the sample was a pooled sample. For example, ringed seal eyes weigh 20 - 40 g each so 5 - 6 pairs were collected per sample. Pooled samples were analysed as a single sample.

As the 500 g samples had to be sufficient for several determinations, a decision was made to remove 150 g from the initial gross sample for the purposes of moisture and vitamin analyses, including vitamin C analysis. Samples were thawed until able to cut with a sharp knife. To ensure that the sub-sample was a representative portion, thin slices were usually taken at equally spaced distances along the entire length of the gross sample. For pooled samples such as the caribou kidneys prepared in the raw and boiled state, the tissue was initially cut in half lengthwise, half to be cooked and half to remain raw for analysis. For whole tissue samples such as raw ringed seal eyes, whole eyes were prepared for analysis. For raw narwhal and beluga mattak, blubber was separated from the skin layers and removed from samples which were held at -80°C to aid in ease of cutting and mincing. Only the skin portion of the mattak was prepared for moisture and vitamin C analysis. Samples were held at -80°C to aid in ease of cutting and mincing. As the mattak often remained difficult to prepare, samples were cut into very thin slices and minced by hand. For caribou stomach samples, the contents were removed from the sac and analysed separately from the lining.

To keep vitamin C losses at a minimum, approximately 30 g of the minced sample was placed in labelled nalgene containers, flushed with nitrogen and placed at -80°C until further analysis. Determinations of vitamin C were made within 90 days of sample arrival in the lab. The remaining sub-portion was placed in a Osterizer home blender and minced finely. From the blended sample, 40 g was weighed, labelled and placed in a nalgene container and placed back in the freezer if moisture analysis could not proceed immediately.

All traditional food was collected in either the raw, aged or dried form. Samples were analysed for vitamin C content in the boiled state if there were adequate samples available. Food items to be analysed for vitamin C in the cooked form were prepared according to a standardized protocol for boiling and then subsequently portioned, labelled and stored appropriately until analysis. Samples to be boiled were weighed in the raw form and placed in nanopure water at a ratio of 1:2 in pre-washed Corning Ware stove-top containers. The water was brought to a boil and reduced to low-medium heat for 15 minutes. The samples were removed from the heat and after cooling for 15 minutes, the cooked sample was drained, re-weighed and portioned for vitamin and moisture analyses.

8.4 Material and Methods for Vitamin C Analysis

Samples were analysed by HPLC with electrochemical detection according to the method of Behrens and Madère (1994b). The chromatographic system (Spectra-Physics) consists of a SP8800 pump, SP8760 autosampler and a SP8760 autosampler cooler, PLRP-S columns, a Chromjet integrator and an electrochemical detector (BAS-Bioanalytical system) with a glassy carbon electrode and an Ag/AgCl reference electrode. The columns were maintained at 5°C.

A calibration curve of 5 standards (0.5 - 2.5 ng) was prepared from an intermediate standard containing AA, prepared fresh weekly and stored at 4°C. To minimize errors arising from changes in the response of the electrochemical detector, standard solutions were injected at frequent intervals (every 5th vial). Peak height was used to determine the concentration of vitamin C. Sample peaks were compared to the calibration curve to calculate sample concentrations and adjusted by peaks obtained from intermittent standard solution injections. The retention time was set at 15 minutes. The limit of detection was 0.5 ng/20 μl.

Samples to be analysed in one day were removed from the -80°C freezer at the beginning of the work day and immediately transferred to an ice bath. Three grams of the already minced sample was weighed to 0.001 g in a pre-weighed, pre-labelled test tube.

The sample was homogenized by a polytron homogenizer for up to 10 s in 1.25 ml of cold 17 % (w/v) HPO_3. This was subsequently diluted to ~25 ml (wt. of sample +HPO_3 + nanopure water weighed to 0.01 g) with nanopure water giving a final concentration ratio of 0.85 % (w/v) HPO_3. Homogenates were centrifuged at 17,000 rpm for 30 minutes in a Beckman refrigerated centrifuge at 4°C. The supernatant was filtered through a 0.22 um Millipore filter unit (Millipore, Bedford, MA). For cloudy samples, the supernatant was filtered twice and/or Whatman's glass fibre filter paper was used. To each of four test tubes was added 500 μl of clear supernatant. For the determination of AA, 115 μl 45 % K_2HPO_4 were added to two test tubes to bring to pH 7.1 from pH 9.8. After 30 minutes 1.385 ml of cold 0.85 % metaphosphoric acid was added to bring to volume of 2 ml. For the determination of DHAA to the third and fourth test tubes 115 μl K_2PO_4 with 1 % homocysteine was added. The test tubes were shaken and left at room temperature for a timed period of 30 minutes (sufficient time for conversion of DHAA to reduced AA), at which point 1.385 ml of cold 0.85 % metaphosphoric acid was added. Using an automated diluter, 100 μl of the treated supernatant was drawn from each test tube into the diluter's syringe which was then injected into a corresponding pre-labelled vial with a flush of 9.9 ml of mobile phase. The mobile phase was 20mM sodium phosphate (monobasic, anhydrous) dissolved in glass distilled water containing 0.17% metaphosphoric acid at a final pH 2.2. which was then filtered through a 0.22 um GS Millipore filter and degassed for a half hour using a water aspirator and followed by bubbling helium continuously. The vial was capped and placed into the autosampler which automatically injects 20 μl into the HPLC system. The analysis was repeated with 500 μl of the treated supernatant and 9.50 ml of the mobile phase for samples with non-detectable levels of vitamin C. For levels > 3.0 ng, the analysis was repeated with 20 μl of the treated supernatant and 9.98 ml of the mobile phase.

The vitamin C data were transferred to Microsoft Excel spreadsheets. Individual replicate values were converted from ng/20 μl to mg/100 g and were recorded for TAA and separately for its two biologically active forms, AA and DHAA. Arithmetic means and standard deviation (SD) were calculated for each traditional food. Due to costs of analyses and known reproducibility of the method (Behrens & Madére 1994a, Hidiroglou *et al.* 1998) only a subset of samples were analysed in duplicate. Recovery studies, carried out on a variety of food matrices, yielded returns of 96 - 100%. The coefficient of variation in repeated assays was less than <10 %. The concentrations of vitamin C in traditional foods were reported as mg/100 g wet weight for raw, boiled or aged foods.

8.5 Materials and Methods for Moisture Analysis

Moisture content was determined in triplicate using the Flexi-Dry MP Microprocessor control Freeze-Dryer (FTS Systems Inc, Stone Ridge, New York) in the laboratory of the Centre for Indigenous Peoples Nutrition and Environment (CINE) at McGill University. Pre-labelled aluminum weigh boats were placed in a drying oven for 1 hour at 120°C, transferred to a desiccator, cooled and weighed. Approximately 50 grams of initial sample were removed from a partially thawed sample and minced fine in a blender. Samples were then refrigerated if moisture analysis was to be conducted within a few hours or transferred to the freezer if delays were expected. Approximately 8 - 10 g of the homogenate (thawed and held at 5°C) was weighed out into a boat. The weigh boats and samples were then placed in the -80°C freezer for one hour to reduce chance of spillage before transfer to the Freeze-Dryer containers. The temperature was lowered to -40°C and the samples were dried for a minimum of 48 hours. Samples were then removed and transferred into a desiccator until weighed. The reported weight was taken at 10 s after placement of the sample on the scientific scale. Moisture values were averaged and reported as the arithmetic mean ± SD. The coefficient of variation in repeated assays was below 5 %.

9. Dietary Evaluations of 20 - 40 Year Old Females

9.1 Dietary Data Management

9.1.1 Relationships Between True and Observed Intake

The number of days of record (D) needed to obtain a given correlation coefficient (r) between the observed and true mean nutrient intakes of individuals was calculated according to the formula in Nelson *et al.* (1989), shown below. The correlation coefficient (r) is a measure of the confidence of classification of subjects. Using values obtained from the literature for a group of women aged 20 - 40 years with n=63 (Nelson *et al.* 1989), and substituting those values into this equation, the number of days required, for r is given below.

$$D=\frac{r^2}{1-r^2} x \frac{S_w^2}{S_b^2}$$

Nutrient	Mean	SD (S_w)	SD (S_b)	CV_b	CV_w
Ascorbic Acid	78.3	38.8	34.7	44.3	49.5

Correlation	r=0.9	r=0.8	r=0.7
Days of recall	5.32	2.22	1.2

A correlation coefficient r>0.9 may be desirable in many studies, however, for the purposes of assessing the mean intake of a population r=0.8 is acceptable (Nelson *et al.* 1989). From the data set available, the number of women who provided 2 or more recalls was 52 (Table 9.1). To have a reasonably good estimation of vitamin C intake, the group mean was estimated from those women who provided 2-6 recalls.

Table 9.1 Number of Recalls among Women Interviewed, 20-40 years, Qikiqtarjuaq, 1987-1988

Number of women	Number of recalls	Percent
8	1	13.3
13	2	21.7
7	3	11.7
10	4	16.7
10	5	16.7
12	6	20

9.1.2 Adjustments to the Data Set

In the community of Qikiqtarjuaq during the interview period there was only one food store with a limited number of fortified food available. Information on products available, levels of vitamin C in fortified food, as well as supplement content and purchase was gathered in store at the time of data collection. On the 24-hour recalls the brand of the product was listed or sufficient information was available to indicate whether the food had added vitamin C.

In the data set itself, fortified products were not coded separately. Drinks made from fruit-flavoured crystals, which were the second most commonly consumed market food, was coded as non-fortified. Dietary recalls from the 1987- 1988 data collection in Qikiqtarjuaq were individually reviewed for use of fortified and non-fortified crystal beverages and juices (Appendix D). Available fruit-flavoured drinks available were Koolaid, Tang and Quench products. Koolaid products marketed in Canada are restricted from addition of vitamin C as they do not meet the requirement for addition of vitamins, according to Section B.11.150 (c) of the Food and Drug Act. This section states that a fruit-flavoured drink cannot contain vitamins if it is represented or commonly known as a 'soft drink, or a thirst-quenching or refreshment drink' (Health Canada 2000). Recalls were reviewed for supplement use.

9.2 Food Composition Databases

The dietary data set was merged with two databases, the CINE - traditional food database and the UCB Mini-list Diet Analysis System (Murphy & Gross, 1987) used at CINE.

9.2.1 Inuit Traditional Food - CINE Database - Inclusion Of Vitamin C Values

The existing Inuit traditional food data base derived from previous published reports (Kuhnlein *et al.* 1991, Kuhnlein & Soueida 1992) had vitamin C values added from this study. For traditional foods that were not analysed and were reported in the recalls, values were imputed from similar traditional food analysed or added from the literature.

For 27 traditional foods in the CINE database specific to the community of Qikiqtarjuaq, the mean vitamin C values from analysed samples were added. Vitamin C values were imputed for 25 traditional foods. The imputed values were based on similar traditional food analysed and/or were calculated from a raw form of the traditional food for boiled and aged food not available for analyses. For all blubber and ringed seal broth, a vitamin C value of zero was entered. There were no missing values for vitamin C in the CINE traditional food database. The traditional food codes and accompanying vitamin C values are found in Appendix E. Imputed values are denoted by an asterisk.

9.2.2 Market Food - UCB Mini-list

The market food data base used was the UCB Mini-list Diet Analysis System. The levels of vitamin C in market food of as per the Canadian Nutrient Data File (CNDF) (1991) were compared with values given in the UCB Mini-list. Values were adjusted where appropriate to levels of the Canadian Nutrient Data File (1991) and information from market food collected in Qikiqtarjuaq in 1987- 1988. A more recent version of the CNDF was not used to avoid errors due to any recent additions of vitamin C in food since the 1980s. A vitamin C value of 25 mg/100 g was assigned to the fortified juice beverage code 3500. The Mini-list codes and the corresponding assigned vitamin C levels are found in Appendix F.

9.3 Statistical Analysis Software

Statistical analyses were conducted using Statistical Analysis System (SAS) for Windows, Version 6.12 (SAS Institute Inc., NC, 1999) software. The mean and range of vitamin C intakes were calculated in each season. The intake of vitamin C was analysed for traditional and market food sources. Market food contribution to vitamin C is further divided between categories of natural and fortified sources. One-way ANOVA were performed to test for significance of seasonal variation for total vitamin C intake, vitamin C intake from traditional food and market food (natural and fortified sources) using SAS Proc-Mixed Model due to the unbalanced nature of the data set.

10. Estimation of Historical Intake of Vitamin C

Estimations of the potential vitamin C content of individual animals used historically by Inuit need to be guided by oral history, current use, the ethnographic and archaeological record, and harvest data. Historically, Inuit decision-making was determined by seasonal availability and climatic considerations, changes in resource abundance or scarcity of resources such as whales, walrus and caribou as well as issues of travel, transport, needs, changes in technology, and involvement in the whaling industry in the

19^{th} century.

The archaeological record, historic record and land use studies indicate that ringed seal has always been a staple in the traditional diet of the Inuit of Baffin Island. It is available throughout most of the year and is the most commonly consumed sea mammal during the winter and spring. Fauna of secondary importance for the Baffinland Inuit were caribou and Arctic char in the summer and fall. Whales were and are available in the late spring to early fall in various areas according to their migration routes. Their importance as food before commercial whaling in the eastern Arctic has been explored by Savelle (1994). For Inuit of Baffin Island, there is a history of hunting whales but relative dietary importance is difficult to determine. From the archaeological record, the remains of whales appear to account for only 3 - 5 % of the animals harvested by Thule, however sites are only from winter villages and some larger mammals such as whales may have been butchered at a kill site distant from camp and bones left on shore or thrown in the water.

Understanding of the current traditional food system of the Baffin Island Inuit and the traditional food used is based on recent nutritional studies (Kuhnlein 1989, Kuhnlein & Soueida 1992) and the work of social scientists. Culture is not frozen in time and shifts in food systems occur due to various factors such as changes in technology, lifestyle, climate, and acculturation.

Recognizing the limitations of assuming that current intake of traditional food can reflect historical intake, reviews were made of ethno-historical records, harvest data, harvest utilization studies and archaeological data for Baffin Island Inuit to estimate the relative contribution of various animal species to the diet in a pre-settlement lifestyle. A library search was also conducted for previous models of pre-contact diet (Rick 1980,Sabo 1981, Keene 1985) and any previous studies which had provided percentage estimates of food categories and/or species (Foote 1967, Stewart & Stahl 1977, Binford 1977, Freeman 1970, Freeman 2000[email], Riewe 1977, Savelle & McCartney 1988). Various separate estimates were calculated based on data obtained from ethnographies, the archaeological record, harvest data and the current mean intake of traditional food in Qikiqtarjuaq. The manner used to calculate these estimates varied for the differing types of data.

There were two general ways to estimate historical intake of vitamin C. The first method was applied to data collected from ethnographies, the archaeological record and harvest data. It required conversion of the gross number of animal species harvested/counted into actual edible parts followed by the calculation of a corresponding vitamin C intake for a set macronutrient ratio and kilocaloric level. The second method used the current intake of traditional food as calculated for residents of Qikiqtarjuaq (Kuhnlein 1989). The proportion of traditional food items in the contemporary diet was kept constant and intake was inflated to 100 %.

10.1 Calculation Of Vitamin C Intake From Ethnographic, Harvest And Archaeological Data

10.1.1 Macronutrient Intake

Vitamin C is found in muscle and organ tissues of animals. As the Inuit diet was largely based on animal food, it was first necessary to understand the relative ratio of macronutrients in a traditional diet. The literature was reviewed for information as to macronutrient intake of coastal Inuit groups from a diet with minimal contributions from market food. In Table 10.1 are listed previous estimates of the macronutrient ratio of protein, carbohydrate and fat in the traditional Inuit diet. Relative ratios of macronutrients were converted to gram weight on the basis of assumptions about an average intake of kilocalories to support an adult in the Arctic and food composition data (Kuhnlein & Soueida 1992).

Table 10.1 Published Macronutrient Ratios for Traditional Coastal Inuit Diets*

Author	Protein	Fat	Carbohydrate
Krogh & Krogh, 1915	48.3 %	46.5 %	5.4 %
Hoygaard, 1941	43 %	54 %	3 %
Heller & Scott 1962	56 %	43 %	1 %
Rabinowitch and Smith, 1936	44.7 %	48.7 %	6.5 %

*Compiled from Foote 1967

10.1.2 Edible Weight Calculations

To arrive at a quantifiable estimate of the contribution of various animals in the diet on a general and yearly basis, data were taken from the archaeological record (Savelle 1994), harvest data (Foote 1967) and ethnographers' reports (Kemp 1971, Hoygaard 1941). The relative contribution of various animals obtained from these studies was calculated into a percentage of total meat/per species. A vitamin C level per animal species was assigned based on information of parts used by humans and their relative weights.

For conversion of species to edible weight and a corresponding vitamin C potential for each animal, a table of Edible Food Weights Of Inuit Traditional Food (Appendix G) was compiled from the literature and information from CINE sample weight lists. As weights calculated by various researchers may not reflect 'culturally determined' edible weight (Lotz 1976), published values were compared and modified on the basis of information as to parts utilized from traditional food use studies (Kuhnlein 1989, Kuhnlein & Soueida 1992), harvest utilization studies (Freeman 1969, Riewe 1977) and ethnographies (Kemp 1971, Borré 1991). Explanations of the values assigned for edible parts of each species used are detailed below. Vitamin C values from analyses on traditional food carried out for this thesis and from the literature were used to calculate a potential vitamin C level (mg/kg) from edible weights.

10.1.2.1 Total edible meat weight

Total edible meat weights for sea and land mammals have been found in various published sources and DIAND reports. Some values are missing and data can only be considered to serve as guides to what is considered an average weight for a specific species.

Descriptions of methods used to derive values are generally lacking. Information on total edible meat weights per animal and edible meat weight/part utilized for traditional food is limited. Factors such as measured or estimated weight, sample size, season, gender, approximate age (calve, youth, adult) are not always explicit. Values for a whole animal may indicate a 'live' weight (carcass with blood and bone) or a carcass with blood removed. Edible meat weights may include meat, fat and organs, calculated together or separately. Some sources did not consider organs separately but listed viscera. I assumed that this would include liver, kidney, stomach and intestines, pancreas and heart. When organs are included separately in these reports, typically only organs that are commonly consumed in 'western culture' are listed, reflecting the cultural bias of these previous studies. Below are further details as to the weights used in Appendix G.

Beluga Values

Values for beluga are taken from an economic survey by Foote (1967) and from field notes of Milton Freeman (Freeman 2000 [email]). Foote compiled weights from the literature, whereas Freeman's data were obtained from the direct butchering of two adult belugas, a male and a female. Freeman provided values for meat (120 kg for the male and 157 kg for the female), organs and a combined value for skin/blubber of 127 kg for the male and 175 kg for the female. The female was 370 cm and the male 375cm in length. The length measurements indicate that the whales were young and probably typical of the age and size hunted by Inuvialiut region Inuit. Based on information from Brodie (1967) the blubber would contribute around 105 kg to a female of 375 cm. On this basis, the maximum amount of mattak would be between 70 - 77 kg as per Foote (1967). For the purposes of this work, a weight of 62 - 77 kg of mattak/beluga was used. This weight range for beluga mattak may overestimate the actual portion consumed. From interviews with Mittimatilik Inuit, there were preferred areas on the whale (back, dorsal surface, sides) and least preferred and/or not used (ventral surface) for cutting mattak. Realistically a value closer to 40 kg may be the highest amount of mattak taken per whale.

Narwhal values

As there are no available values for narwhal, values were imputed from beluga as the two species are similar in weight.

Caribou values

Caribou values are taken from Binford (1978), Foote (1967) and Spiess (1979). Foote's values are compiled from various sources. Foote provides a breakdown of percentage of total weight: 10 % from fat, 35 % from meat, 20 % from organs and 25 % from bones with the remainder from blood and skin. Fat in male caribou as a percentage of weight varies seasonally from 10 - 20 % (Spiess 1979). Male caribou are at their heaviest in late summer and lose their extra fat by the end of fall. Females are generally slim during the summer and heaviest in the winter. Therefore meat as a percentage of weight would range between 32 - 35 % and organs form 17 - 20 % of the total weight.

Binford's weight are from one bull caribou butchered in August. As only a combined weight is given for fat and meat as 43 kg, the weight of meat alone based on 20 % fat of the total weight is 23 kg. Spiess (1979) has average weights for barren ground caribou of different body size, sex and in different seasons. Weight for male caribou vary between 81 - 153 kg and for females 57 - 84 kg. The average weight for a medium sized male barren ground caribou is 110 kg in September. From the total weight, 20 kg (20 %) is fat and 30 kg is meat. For female caribou, Spiess gives an average weight of 72 kg with 10 % (7 kg) as fat and 23 kg as meat. From these various sources, the average meat yield range (excluding organs) is 23 - 32 kg. It was assumed that the fat within the meat was minimal.

Bowhead whale

The average weight of a bowhead varies from ~9,000 kg for an immature whale to >27,000 kg mature (Savelle 1988) although some may weigh up to 50,000 kg. Our knowledge of historic Inuit use and exploitation of whales is weak but Baffinland Inuit hunted bowhead whales in Cumberland Sound prior to the whaling era. Indeed it was an Inuk from Cumberland Sound who detailed on maps of Captain Penny all of the best places to catch whales in Cumberland Sound circa 1837. Savelle (1988) believes there is strong evidence based in part on a recent ethnographic description of Thule hunting of bowheads from Alaska that younger whales were generally taken due to safety and taste reasons. It is probable that historic Inuit preferred immature whales, given current hunting preference for younger belugas and younger narwhals. From an archaeological survey (McCartney 1978), all bowheads measured were 7-10 m in length, that is immature whales under 2 years which would have corresponded to lower weights of 9 - 10,000 kg. A whale of this size still could potentially have supplied enough energy for a group of 100 people and 60 dogs for over 1 month.

Ringed Seal

The average weight of a ringed seal ranges from 45 to 114 kg. Blubber may range from 32 % of weight in summer and 40 % in winter (Maclaren in Rick, 1981). It is estimated that only 30 % was utilized by humans (meat, organs, blubber) (Freeman 1969, Riewe 1977, Maclaren in Rick 1981).

10.1.2.2 Harvest utilization

Edible weights from various sources do not appear to take into consideration "culturally-determined" edible meat (Lotz 1976). Weight data may overestimate the quantity of various parts utilized and thereby overestimate the percentage of total weight and nutritional importance that various animals contribute to the diet. Data from harvest utilization studies below provided from two Inuit communities the percentage of human use consumption of the animal species and differences due to age. These data however, may underestimate the contribution of animals harvested to percentage of total weight due to factors which include acculturation.

In Table 10.3, data from Freeman (1970) and Riewe (1977) reflect harvest data prior to abandonment of dogs in favour of snowmobiles. This more accurately reflects the ratio of dogs to humans and relative consumption by humans and dogs of animals harvested. While current use may not reflect historical use, it provides information as to the relation between potential edible weight and culturally determined edible weight.

With changes in lifestyle from nomadic to permanent settlements, acculturation and involvement in the wage economy, there have been shifts in patterns of hunting and potentially the relative use of animals. Among the Southampton Inuit, meat and organs of ringed seal were for human consumption whereas meat of whale and mattak were often considered as dog food, the mattak being reserved for human use (Freeman1969). Riewe (1977) recorded that Grise Fiord Inuit consumed the meat, blubber, liver, intestine and heart of ringed seals, preferring young seals. Dogs consumed the remainder of seals not eaten by humans.

Distance from settlement while hunting plays an important role in utilization. If polar bear hunting occurred far away from the settlement, much of the meat was fed to the dogs and left for scavengers. Historically, groups may have carried the meat with them and/or cached it for themselves. Freeman (1970) found that depending on the season and climate, a great portion of the walrus including some preferred meat such as the heart might be abandoned at the kill site.

Age and gender also play a role in Inuit hunting practices. Freeman (1970) noted a greater human consumption of younger animals. Similarly, Brodie (1967) recorded that Inuit hunters preferentially took smaller belugas for food use. Published sources often provide an average weight without information as to age, thus potentially overestimating actual weight/animal. In the case of beluga whales, younger males are usually taken as they are easier to hunt and females with calves are generally avoided (Freeman *et al.* 1998). Issues of safety generally influence harvesting towards the walrus sub-adult/young adult population.

Freeman (1969) calculated an availability/capita/annum of 136.6 kg for humans and 236.9 kg for dogs from catch statistics for Southampton Island in 1961. Freeman did not provide separate contribution from blubber/meat/organs nor were consumption of caribou, char, hare, birds and plants nor the percentage of imported foods eaten taken into account. Historically, it could be assumed that either more animals were taken or a greater percentage of the animals were used by humans. In contrast to Freeman's figures, Borré (1991) indicated that in Clyde River, the mean weight of country food available per capita/year was 379 kg in 1973, 329 kg in 1980 and 296 kg in 1984-85. In 1980 the weight of store food estimated by Borré was 264 kg and 364 kg in 1985. It appears that the weights reflect liquids and solids combined.

Table 10.2 Harvest Utilization Data (Wt in kg)					
Animal	Freeman (1969) Population, 200 humans, 400 dogs)			Riewe (1977)	
	Avg wt.	Inuit use	Dog use	Avg wt.	Inuit use
Ringed Seal	40	14	12	48	14 (meat), 8 (viscera)
Bearded Seal	270	27	148		
Beluga	450	63 (meat & mattak)	270	450	76 (mattak & meat)
Narwhal				540	80 (mattak)
Polar bear	365	37 (meat)	128	270	20
Walrus-adult	512	25	333		
sub-adult	305	61	152		
calf	103	20	50		
Arctic char				1.5	1.2
Ptarmigan					0.25
Arctic hare				3.76	2

10.1.3 Ethnographic, Harvest and Archaeological Data

Kemp (1971) estimated the percentage of kilocalories provided for animal and plant food commonly harvested by outpost camp residents in Lake Harbour. Hoygaard (1941) similarly provided an estimate of the kilocaloric contribution of various animals in the diet of Greenland Inuit. Assuming that the relative importance of the animals eaten was not substantially different from historical Inuit lifestyles, the proportion of kilocalories provided by each food was converted into a corresponding expected fresh weight basis for a 2500 kcal diet and a potential vitamin C intake was calculated.

Harvest data for Qikiqtarjuaq for the year 1965 - 1966 were taken from Foote (1967). At the time of harvesting, dogs had been largely replaced by snowmobiles. Since the sealing economy was very important at the time, seals may be over represented in comparison to a historical diet of those Inuit living on the eastern coast of Baffin Island.

Noticeably there were no whales harvested. The estimation based on this data stands as an interesting calculation for a diet without one of the richest sources of vitamin C, that is mattak.

Archaeological data were taken from Savelle (1994) and Sabo (1981). The sites represent Classical, Developed and Historic Thule culture respectively and are found on the southern and eastern side of Baffin Island. The faunal assemblage consists of a Minimum Number of Individuals (MNI) which were converted into edible weights using values in Table 10.2 and Appendix G. Vitamin C values were calculated based on edible weights.

10.2 Calculation of Vitamin C Intake Based on Current Traditional Food Use

A historical estimate of vitamin C intake was also calculated from the 1987-88 Qikiqtarjuaq data set. Currently, traditional food contributes 20 to 30 % of the diet in low to high use periods. The top 30 traditional food items ranked by percentage of total fresh weight were converted to a percentage of total kilocalories. The weight and vitamin C value for traditional food on a 2500 kilocalorie diet were then calculated.

10.3 Limitations

Ethnographies, harvest studies, the archaeological record and current food use can provide useful information on cultural food resources and relative importance. Deriving a potential vitamin C intake on the basis of information from these studies can provide us at best no more than a crude estimate of intake. Limitations include 1) changes in human consumption of parts used over time and with seasons; 2)within and between group variation; 3) ignorance of gender or age use specialization; 3) harvest studies often record total kills, not animals retrieved; 4) harvest studies reflect recent changes in use as a result of ammunition and the fur economy; 5) archaeological sites from Thule culture on Baffin Island reflect winter villages which were used for 6 months/year (Savelle 1994); 6) bones used to indicate MNI may overestimate the importance of smaller animals returned whole to the village site as larger mammals such as whales may have been butchered at a distance from the harvest site and only meat, skin and blubber may have been carried back to the village; 7) lack of floral remains at archaeological sites; 8) historically, ethnographers were men and they may not have been privy to knowledge of women's role in subsistence; 9) current traditional food use patterns in a settlement lifestyle do not reflect relative contribution of animal and plant species for historic, nomadic Inuit.

11. Qualitative Interviews On Inuit Perspectives Of Food And Vitamin C

Interviews took place in Mittimatilik during the spring of 1999. Interviews were semi-structured with several (n=15) key informants. Sampling was by convenience. Categorized by age and gender, there were 8 adult women and 3 men under the age of 40, 2 women between the ages of 40-50 and 2 women over 60. Discussions focussed around the meaning and achievement of health, the roles of traditional and market food in the diet, changes in traditional food use which may impact nutrient intake, particularly vitamin C, and influences on food choice with respect to market food sources such as (fresh/frozen juice, unfortified vs. fortified fruit drink powders). The list of questions is given in Appendix H.

The methodology of using loosely structured key informant interviews is a standard one for ethnography for collecting narratives about contemporary and historic experiences. Though it could be argued that the voices discussed here are idiosyncratic in comparison to statistical modelling, they have the distinct advantage of bringing relevant narratives and perspectives that would not be captured in the social response to more formal, quantifiable surveys. Thus, this narrative methodology represents a useful and insightful way to bring Inuit 'perspectives' (emphasis on plurality, not statistical generality) to this scientific work.

IV. RESULTS AND DISCUSSION

12. Traditional Food Analysis

Half of the samples targeted for analysis were available in a sample size of $n \geq 3$ from more than 2 geographical locations during the fall and winter/spring collection periods. Availability limitations were a factor for some samples analysed. It is acknowledged that a greater number of replicates per sample (n>3) would be preferred. It is clear that even a single sample can provide valuable information as to the potential vitamin C content of a traditional food. Table 12.1 presents the values obtained from moisture and vitamin C analyses of the selected Inuit traditional food listed by species, common name and part used.

12.1 Moisture

As anticipated, moisture content was highest in plants. The berries analysed had similar moisture contents of between 84 - 88 g/100 g. Kelp had a lower moisture content between 72 - 74 g/100 g. The moisture content of the raw animal traditional food generally ranged from 70 - 80 g/100 g, exceptions being ringed seal eyes with a higher moisture level (85.70 ± 1.84 g/100 g), and raw beluga mattak (skin only) which had a moisture content of 68.43 ± 2.71 g/100 g. Cooked samples had a lower moisture content between 60 and 70 g/100 g due to loss of tissue moisture. The single sample of dried beluga meat had a moisture content of 42.03 g/100 g. Narwhal mattak (skin only) was available only in the raw and aged form. Aged mattak had a moisture content of content of 62.31 mg/100 g. Walrus kauk (skin) had a noticeably low moisture content of 34.85 g/ 100 g. The moisture content of the individual replicates is given in Table 12.2. The CV for all analytical samples was less than 5 %.

12.2 Vitamin C

This thesis provides the first reports of vitamin C values for several Inuit traditional foods. The analytical results for individual replicates of traditional food are displayed in Table 12.2. Standard deviations are given for replicates for which two extractions were done. Particular to the method used for analysis of vitamin C is the combined step of homogenization and extraction of vitamin C. As homogenization introduces oxygen, the sample was homogenized in metaphosphoric acid which acts to both protect and separate vitamin C from the food matrix.

After analysis of each sample, the remaining supernatant was placed at -80°C. A few frozen supernatants, initially analysed in February, were re-analysed in June during tests of the HPLC equipment. The results in Table 12.3 indicate that the magnitude of loss of vitamin C was inversely related to the initial level of vitamin C. Due to the time and cost of separate extractions per replicate, duplicate extraction was performed on a subset of samples (Table 12.4). The coefficient of variation was less than 10 % A few samples were extracted for a second time several months apart. The results indicate that losses of vitamin C from the intact sample kept at -80°C were minimal and lower than losses between fresh and frozen supernatants.

12.2.1 Plant Sources

The coefficient of variation of vitamin C in natural sources of food has been estimated at 30 % approaching a range of 5 - 50 % at levels below 7.5 mg/100 g and between 10 - 30 % at higher levels (Pennington 1975, Beaton 1987) as mentioned in Section 2.1.3. In the plant category of traditional food analysed for vitamin C, the CV between replicates of cranberries, *Vaccinium vitis-idaea*, and blackberries, *Empetrum nigrum*, were 33 % with levels of vitamin C below 4 mg/100 g and 3 mg/100 g respectively. The CV for the analysed samples of blueberries *Vaccinium uliginosum* was 18 % with an average of 26.20 mg/100 g.

Previous analyses of *Vaccinium vitis-idaea* (Appendix A) indicate levels for vitamin C between 17 - 22 mg/100 g compared to the replicate levels of 2.93 mg and 4.82 mg/100 g found in this study. Unlike previous analyses of *Empetrum nigrum* (Appendix A) which indicate a range of 9 - 51 mg /100 g the values obtained in this study were lower with a much smaller range of 1.67 - 3.57 mg/100 g (n=5). Kuhnlein (1989) reported a value of 16.4 mg/100 g (n=1) for this species from berries obtained at Bella Coola. However, samples of blueberries *Vaccinium uliginosum* gave values of vitamin C between 22.56 - 31.91 mg/100 g with a mean value of 26.20 mg/100 g.

In the samples of cranberries and blackberries vitamin C was present primarily as DHAA. DHAA, although biologically active, is the first step in the conversion to the inactive form 2,3-diketogulonic acid. Some conversion from AA to DHAA may be a result of the extraction process, but this conversion is minimized by homogenization of the sample in HPO_3 (metaphosphoric acid) in an ice bath for a limited time period (10 s). Conversion from AA to DHAA and the inactive form 2,3-diketogulonic acid can occur more rapidly in food stored above -18°C and complete conversion may occur in less than two months at temperatures of -2°C (Guadagni and Kelly 1958 in Kramer 1979). Significant losses may also occur if fresh food remains at ambient temperature for several hours post-harvest (Fennema 1977). As the berries were harvested and stored in similar manners, the differences may be due to genetic variation, maturity and variation in the levels of sugar, minerals and antioxidants (Tannenbaum *et al.* 1985). However, it would be valuable to conduct further analysis of vitamin C on these arctic species to investigate whether there is a different susceptibility to losses of vitamin C under usual home storage conditions.

There are a variety of marine plants in the Arctic. Only two species were available and these were both harvested near the island of Qikiqtarjuaq, Baffin Island during freeze-up in October. The sample identified as *Laminaria spp.* contained a considerably higher level of vitamin C than the sample of *Fucus spp.*. For the purposes of dietary intake analysis, the vitamin C value for kelp was taken as an average of these two species. Further work needs to be done to assess whether certain marine plants are preferentially used.

12.2.3 Animal sources

Animal sources of traditional food confer fair to excellent amounts of vitamin C in a daily diet. Among the animal sources of traditional food, the highest levels of vitamin C were found in samples of raw beluga and narwhal mattak, boiled beluga mattak, aged narwhal mattak, fish roe, ringed seal and caribou liver, ringed seal brain and caribou kidney. The most commonly consumed traditional food were frozen/raw meats, which as anticipated, contained approximately 1 mg/100 g.

In this study, the highest levels of vitamin C were found in the skin of the narwhal and beluga whales and the cisco roe. Cisco eggs contained vitamin C levels of 49.60 ± 12.30 mg/100 g. Whales are important to Inuit socially, culturally, economically, and as a food source. Mattak (whale skin) has always been a highly favoured traditional food and was considered by the Danes as an excellent preventative against scurvy, often more effective than available fruits and vegetables (Bertelsen 1911 in Hoygaard 1941). Samples of beluga mattak raw had levels of vitamin C at 36.02 ± 8.73 mg/100 g and narwhal mattak had levels of 31.51 ± 6.96 mg/100 g. Aged narwhal mattak, a favourite fermented delicacy, which is prepared by caching outdoors under large rocks for at least 6 months, had vitamin C levels of 20.68 ± 4.15 mg/100 g or 65 % of the vitamin C found in raw samples. Previous published reported indicated that beluga mattak contained (Appendix A) levels of vitamin C between 2 - 25 mg/100 g and between 20 - 32 mg/100 g in narwhal mattak. There were no previous reported values for boiled mattak and only one analysis of aged narwhal mattak by Hoygaard (1941) with a reported level of 0.6 mg/100 g.

From the ubiquitous ringed seal, a staple of the Inuit diet, samples of raw liver, raw and boiled meat, raw brain, eyes and blood were analysed for vitamin C. Both the liver and brain are good sources of vitamin C. A range of 21.14 - 28.18 mg/100 g (n=3) of vitamin C was found in the analysis of the liver and a range of 11.60 - 17.93 mg/100 g was obtained for the samples of raw brain (n=4). Raw meat analysed (n=3) gave values of vitamin C between 1.16 - 2.14 mg/100 g. There was only one sample of boiled meat available and the level of vitamin C was 1.19 mg/100 g. Ringed seal eyes contained between 2.67 - 3.95 mg/100 g of vitamin C. Ringed seal whole blood (n=6) contained very low levels of vitamin C, between 0.00 - 0.14 mg/100 g. While some AA may have been oxidized due to the presence of iron, it is unlikely that higher levels of vitamin C would be found considering that plasma values for rats indicate an average of 0.6 mg/100 g in plasma (Behrens & Madère 1987).

There were limited samples of bearded seal meat and intestines available. Two samples of both were analysed in the cooked form. In some communities ringed seal intestines and whale intestines are also used but these were not available nor measured in this project. Bearded seal meat is usually cooked unlike ringed seal meat which is commonly eaten in both the frozen/raw, raw and cooked form. Vitamin C values for the bearded seal meat were 0.59 mg/100 g and 1.31 mg/100 g. Boiled bearded seal intestines showed significant variation between samples with a mean of 6.12 ± 4.90 mg/100 g.

The walrus is a valued source of traditional food, prized for its meat which is often fermented for several months inside the skin of the walrus buried in the ground. Other parts which may be eaten include the kauk (skin) and stomach contents. Walrus samples were limited during the fall and winter collection period. Only single samples were available for analysis of raw and aged walrus meat and skin. The sample of walrus meat raw gave a value of 1.00 mg/100 g of vitamin C. Similarly, the aged walrus meat had a value of 0.85 mg/100 g. Unlike the whale mattak, the walrus kauk had a low level of vitamin C at 0.70 mg/100 g.

Caribou heart, liver, meat, kidney, stomach and stomach contents were analysed for vitamin C levels. Caribou liver contained 23.76 ± 4.92 mg/100 g of vitamin C. Caribou kidneys raw and boiled contained 8.88 ± 0.37 mg/100 g and 7.24 ± 3.14 mg/100 g of vitamin C respectively. Caribou stomach contents and caribou stomach had negligible amounts of vitamin C. Rodahl (1949) stated that caribou stomach was the main vegetable source of vitamin C for the Inuit, although in his results he only provided values for the stomach of arctic hare (10 mg/100 g). One elder laughingly described the contents of caribou and hare as salad and remember that in the past the hare stomach was a favourite children's food (elder, Mittimatilik, personal communication). The caribou stomach and stomach contents analysed in this study were obtained during the winter months and were primarily from Mittimatilik hunters. The contents appeared to be primarily composed of lichen and contained only 1.01 ± 1.02 mg/100 g of vitamin C. It is possible that the contents would give higher values if obtained during the summer months. I posed the question of seasonal variation to a hunter. He told me that the caribou stomach is greener around the outpost camps such as Low Point (100 km N.E. of Mittimatilik) and that caribou nearer to the settlement have browner contents. His answer implies variation in the forage plants available and consumed by caribou. It does not include a response as to whether certain contents were preferred. The contents of caribou stomachs in the summer will contain other plants such as the leaves and buds of willow which may result in a greater vitamin C content. Others informed me that caribou available further away from Mittimatilik tasted better and was preferred. These interesting personal observations are indicative of an underlying knowledge system and decision-making processes around food choices. It is not possible to quantify whether any of the samples collected, which were exchanged for cash, were in any way non-representative of food consumed.

Table 12.1 Vitamin and Moisture Values for Analysed Inuit Traditional Food

Type	Species	Common name	Part	Preparation	n	Moisture	SD	n	Vitamin C mg/100 g	SD
PLANTS	*Vaccinium vitis- idaea*	Cranberries	berries	raw	2	84.35	1.34	2	3.88	1.30
	Vaccinium uliginosum	Blueberries	berries	raw	3	85.41	1.31	3	26.20	4.90
	Empetrum nigrum	Blackberries	berries	raw	5	87.96	1.11	5	2.41	0.80
	Oxyria digyna	Mountain Sorrel	leaves & stem	raw	1	86.89		1	41.57	
	Fucus spp.	Kelp	plant	raw	1	72.49		1	4.37	
	Laminaria spp.	Kelp	plant	raw	1	73.85		1	28.36	
SEA MAMMALS	*Phoca hispida*	R. Seal	liver	raw	3	72.35	0.39	3	23.80	3.82
		R. Seal	meat	raw	3	70.33	1.64	3	1.55	0.50
		R. Seal	meat	boiled	1	64.92		1	1.19	
		R. Seal	brain	raw	4	77.54	0.10	4	14.86	2.60
		R. Seal	eyes (pooled)	raw	3	85.70	1.84	3	3.17	0.68
		R. Seal	blood	raw	6	70.44	4.50	6	0.04	0.06
	Erignathus barbatus	B. Seal	intestines	boiled	2	74.65	0.64	2	6.12	4.90
		B. Seal	meat	boiled	2	62.68	0.64	2	0.95	0.50
	Delphinapterus leucas	Beluga	mattak	raw	6	68.43	2.71	6	36.02	8.73
		Beluga	mattak	boiled	2	60.61	13.07	2	23.63	4.66
		Beluga	meat	dried	1	42.03		1	1.14	
	Monodon monoceros	Narwhal	mattak	raw	6	71.71	1.88	6	31.51	6.96
		Narwhal	mattak	aged	1	62.31		2	20.68	4.15
	Odobenus rosmarus	Walrus	meat	raw	1	73.10			1.00	
		Walrus	meat	aged	1	64.05			0.85	
		Walrus	mattak	raw	1	64.40			0.70	
LAND MAMMALS	*Rangifer tarandus*	Caribou	heart	raw	3	76.59	1.57	3	2.60	0.41
		Caribou	meat	raw	1	71.04		1	0.86	
		Caribou	liver	raw	4	71.49	3.16	4	23.76	4.92
		Caribou	stomach	walls	6	78.61	3.38	6	0.45	0.39
		Caribou	stomach	contents	3	78.86	1.38	3	1.01	1.02
		Caribou	kidney	raw	3	74.80	4.43	3	8.88	0.37
		Caribou	kidney	boiled	4	65.01	3.00	4	7.24	3.14
FISH	*Salvelinus alpinus*	Char, Arctic	flesh	raw	2	80.96	1.48	2	1.23	0.03
	Myoxocephalus spp.	Sculpin	flesh	raw	1	79.47		1	1.05	
	Coregonos nasus	B. Whitefish	flesh	raw	3	73.53	5.46	3	2.83	1.11
		B. Whitefish	flesh	boiled	2	69.63	1.39	2	2.15	0.16
	Coregonus spp.	Cisco	eggs (pooled)	raw	2	62.56	3.98	2	49.60	12.30
SHELLFISH		Clams	meat	raw	2	77.63	0.64	2	3.69	3.10
BIRD	*Lagopus mutus Mont.*	Ptarmigan	meat	raw	1	73.49		1	1.70	
		Ptarmigan	whole	boiled	1	62.38		1	2.89	

The n for pooled samples reflects the number of separate 500 g initial samples. Pooled samples indicate samples from >1 animal to attain a 500 g sample.

Table 12.2 Analytical Results for Individual Replicates - Moisture (g/100 g) and Vitamin C (mg/100 g)

Food category	Common Name	Part	Preparation	Code #	Moisture	SD	Vitamin C analysis	# of extractions	TAA	SD	AA	DHAA
Fish & Shellfish	Arctic char	flesh	raw	IN107	82.00	0.45	Feb 99	1	1.25		0.91	0.34
	Arctic char	flesh	raw	IN49	79.91	0.14	Sept 99	2	1.21	0.05	0.73	0.50
	Sculpin	flesh	raw	IN18	79.47	0.72	Feb 99	1	1.05		0.06	0.99
	B. Whitefish	flesh	raw	IN41-1	69.02	0.94	Feb 99	1	4.62		4.34	0.28
	B. Whitefish	flesh	raw	IN41-2	71.98	0.71	Feb 99	1	3.05		2.20	0.85
	B. Whitefish	flesh	raw	IN50	79.60	0.19	Feb 99	1	0.83		0.42	0.41
	B. Whitefish	flesh	boiled	IN41-1	70.62	0.10	Feb 99	1	2.27		1.58	0.69
	B. Whitefish	flesh	boiled	IN41-2	68.65	0.19	Feb 99	1	2.04		1.56	0.48
	Cisco	roe	raw	IN31	65.38	0.08	Feb & June 99	2	40.88	0.60	29.71	11.17
	Cisco	roe	raw	IN40	59.75	0.47	June 99	2	58.32	4.80	41.20	17.12
	Clams	flesh	raw	IN9	77.17	0.17	Feb 99	1	1.53		0.25	1.27
	Clams	flesh	raw	IN2	78.08	0.15	Feb 99	1	5.85		3.64	2.21
Plants	Kelp	whole	raw	IN20	73.85	0.22	June 99	2	28.36	1.01	14.45	13.92
	Kelp	whole	raw	IN19	72.49	0.16	Feb 99	1	4.37		0.34	4.03
	Mountain Sorrel	leaves & stem	raw	IN23	86.89	0.05	June 99	1	41.57		11.62	29.95
	Blackberries	berry	raw	IN90	87.99	0.65	Feb 99	1	1.82		0.00	1.82
	Blackberries	berry	raw	IN84	86.39	1.35	Feb 99	1	1.67		0.00	1.67
	Blackberries	berry	raw	IN113	89.39	0.31	Feb 99	1	3.57		1.21	2.36
	Blackberries	berry	raw	IN22	87.57	0.29	Feb 99	1	2.71		0.00	2.71
	Blackberries	berry	raw	IN45	88.45	0.98	Feb 99	1	2.30		0.00	2.3
	Blueberries	berry	raw	IN85	86.93	0.03	Feb & June 99	2	31.91	0.08	28.13	3.63
	Blueberries	berry	raw	IN116	85.30	0.13	June 99	1	22.56		18.74	3.82
	Blueberries	berry	raw	IN92	84.87	0.03	June 99	2	23.32	1.15	16.89	6.43
	Cranberries	berry	raw	IN59	85.30	0.13	Feb 99	1	2.93		1.28	1.66
	Cranberries	berry	raw	IN91	83.40	0.15	Feb 99	1	4.82		1.78	3.05
Bird	Ptarmigan	meat	raw	IN105	73.49	0.17	Feb 99	1	1.70		0.00	1.70

Table 12.2 Analytical Results for Individual Replicates - Moisture (g/100 g) and Vitamin C (mg/100 g)												
Food category	Common Name	Part	Preparation	Code #	Moisture	SD	Vitamin C analysis	# of extractions	TAA	SD	AA	DHAA
Bird	Ptarmigan	whole	boiled	IN115	62.38	0.56	Feb 99	1	2.89		0.00	2.89
Land Mammal	Caribou	heart	raw	IN149	75.77	0.24	June 99	1	2.62		0.00	2.62
	Caribou	heart	raw	IN179	75.61	1.34	June 99	1	2.57		0.00	2.57
	Caribou	heart	raw	IN165	78.40	0.39	June 99	1	1.89		0.00	1.20
	Caribou	kidney	raw	IN29	71.67	1.34	Feb 99	2	9.14	0.35	3.78	5.37
	Caribou	kidney	raw	IN42,44	77.94	0.03	Feb 99	1	8.62		4.00	4.62
	Caribou	kidney	boiled	IN42,44	67.13	0.16	Feb 99	1	5.02		2.42	2.60
	Caribou	kidney	boiled	IN43,30	62.89	0.25	Feb 99	1	9.46		6.48	2.98
	Caribou	liver	raw	IN96	73.53	0.04	Feb 99	1	26.50		20.74	5.77
	Caribou	liver	raw	IN153	68.26	0.08	June 99	1	28.42		24.53	3.89
	Caribou	liver	raw	IN166	74.79	0.05	June 99	1	18.94		8.91	10.03
	Caribou	liver	raw	IN170	69.37	0.05	June 99	1	19.17		13.96	5.21
	Caribou	meat	raw	IN48	71.04	0.37	Feb 99	1	0.86		0.08	0.78
	Caribou	stomach	raw	IN169	82.06	0.44	June 99	1	0.36		0.00	0.36
	Caribou	stomach	raw	IN151	75.00	0.32	June 99	1	0.24		0.00	0.24
	Caribou	stomach	raw	IN167	77.79	0.29	June 99	1	1.11		0.00	1.11
	Caribou	stomach	raw	IN171	76.10	0.15	June 99	1	0.68		0.00	0.68
	Caribou	stomach	raw	IN173	83.44	0.46	June 99	1	0.30		0.00	0.30
	Caribou	stomach	raw	IN150	77.27	0.15	June 99	1	0.00		0.00	0.00
	Caribou	stomach	contents	IN168	79.15	0.65	June 99	1	0.99		0.00	0.99
	Caribou	stomach	contents	IN152	80.07	0.12	June 99	1	2.04		0.11	1.93
	Caribou	stomach	contents	IN172	77.35	0.20	June 99	1	0.00		0.00	0.00
Marine Mammals	Beluga	mattak	raw	IN6	66.78	1.52	Feb 99	1	47.71		44.83	2.88
	Beluga	mattak	raw	IN140	72.31	0.05	June 99	1	27.75		24.62	3.13
	Beluga	mattak	raw	IN211	65.45	0.17	June 99	1	32.38		32.04	0.34
	Beluga	mattak	raw	IN209	69.49	0.38	June 99	1	31.56		29.65	1.90
	Beluga	mattak	raw	IN202	66.16	0.58	June 99	1	46.49		45.25	1.24
	Beluga	mattak	raw	IN200	70.41	0.34	June 99	1	30.23		29.88	0.34
	Beluga	mattak	boiled	IN34	64.61	0.58	Feb 99	1	26.92		23.30	3.62
	Beluga	mattak	boiled	IN37	56.61	0.92	Feb & June 99	1	20.34		18.97	1.56
	Beluga	meat	dried	IN4	42.03	1.02	Feb 99	1	1.14		0.00	1.14
	Narwhal	mattak	raw	IN1	69.54	0.51	Feb 99	1	33.34		29.89	3.44
	Narwhal	mattak	raw	IN3	70.82	0.53	Feb 99	1	24.53		21.51	3.03

Table 12.2 Analytical Results for Individual Replicates - Moisture (g/100 g) and Vitamin C (mg/100 g)

Food category	Common Name	Part	Preparation	Code #	Moisture	SD	Vitamin C analysis	# of extractions	TAA	SD	AA	DHAA
Marine Mammals	Narwhal	mattak	raw	IN212	70.65	0.46	June 99	1	32.16		30.07	2.09
	Narwhal	mattak	raw	IN145	71.40	0.23	June 99	1	36.04		36.12	-0.08
	Narwhal	mattak	raw	IN141	73.19	0.37	June 99	1	22.30		21.62	0.48
	Narwhal	mattak	raw	IN138	74.66	0.06	June 99	1	40.69		39.56	1.14
	Narwhal	mattak	aged	IN183	62.31	0.07	June 99	1	16.53		10.65	5.88
	Narwhal	mattak	aged	IN184	6.41	1.50	June 99	1	24.84		24.18	0.66
	R. Seal	blood	raw	IN204	72.15	1.94	June 99	1	0.00		0.00	0.00
	R. Seal	blood	raw	IN161	68.06	1.39	June 99	1	0.09		0.00	0.00
	R. Seal	blood	raw	IN157	75.33	0.85	June 99	1	0.00		0.00	0.00
	R. Seal	blood	raw	IN208	75.37	1.23	June 99	1	0.14		0.00	0.14
	R. Seal	blood	raw	IN164	66.96	0.12	June 99	1	0.00		0.00	0.00
	R. Seal	blood	raw	IN148	64.75	0.36	June 99	1	0.00		0.00	0.00
	R. Seal	brain	raw	IN24	77.45	0.08	Feb. 99	1	11.60		3.18	8.42
	R. Seal	brain	raw	IN163	77.59	0.01	June 99	1	17.93		8.36	9.58
	R. Seal	brain	raw	IN162	77.56	0.44	June 99	1	15.65		7.24	8.40
	R. Seal	brain	raw	IN160	77.54	0.79	June 99	1	14.25		2.01	12.2
	R. Seal	eye	raw	IN10	87.00	0.35	June 99	1	3.95		3.38	0.57
	R. Seal	eye	raw	IN82	84.39	0.45	June 99	2	2.90	0.20	1.715	1.175
	R. Seal	eye	raw	IN79	68.71	1.18	June 99	2	2.67	0.35	1.32	1.35
	R. Seal	liver	raw	IN71	72.66	1.56	Feb & June 99	2	21.14	0.13	10.52	10.615
	R. Seal	liver	raw	IN66	71.91	1.57	Feb. 99	1	22.08		9.72	12.36
	R. Seal	liver	raw	IN17	72.48	0.04	Feb. 99	2	28.18	2.59	22.28	5.90
	R. Seal	meat	raw	IN67	68.51	0.03	Feb. 99	1	1.34		0.00	1.34
	R. Seal	meat	raw	IN70	70.79	0.07	Feb. 99	1	2.14		0.00	2.14
	R. Seal	meat	raw	IN16	71.70	0.07	Feb. 99	1	1.16		0.00	1.16
	R. Seal	meat	boiled	IN70	64.92	2.08	Feb. 99	1	1.19		0.00	1.19
	B. Seal	meat	boiled	IN87	62.23	0.01	Feb. 99	1	0.59		0.00	0.59
	B. Seal	meat	boiled	IN11	63.13	0.40	Feb. 99	1	1.31		0.13	0.21
	B. Seal	intestines	boiled	IN86	75.10	0.33	Feb. 99	1	9.60		7.42	2.18
	B. Seal	intestines	boiled	IN12	74.19	0.23	Feb. 99	1	2.64		1.75	0.88
	Walrus	kauk	raw	IN55	34.85	1.86	Feb. 99	1	0.70		0.00	0.70
	Walrus	meat	aged	IN88	64.05	0.30	Feb. 99	1	0.85		0.00	0.00
	Walrus	meat	raw	IN52	73.10	0.50	Feb. 99	1	1.00		0.00	1.00

Table 12.3 Change in Vitamin C Levels as Measured in Fresh and Frozen Supernatants					
Common Name	Part	Preparation	Date	TAA	Change
B. Whitefish	flesh	raw			
			Feb-99	4.62	
			Jun-99	3.71	
				-0.91	~20 % over 4 months
Beluga	mattak	boiled			
			Feb-99	21.52	
			Jun-99	19.15	
				-2.37	~11 % over 4 months
Blueberries	berry	raw			
			Feb-99	31.96	
			Jun-99	31.85	
				-0.11	~0.3 % over 4 months

Table 12.4 Subset of Samples Subject to Two Extractions								
Common Name	Part	Preparation	Code #	Date	Extraction	TAA	SD	CV
Cisco	roe	raw	IN31	June 99	Average	40.88	0.60	1.47
					1st	40.45		
					2nd	41.30		
Cisco	roe	raw	IN40	June 99	Average	58.32	4.80	8.23
					1st	61.71		
					2nd	54.92		
Arctic char	flesh	raw	IN49	Sept. 99	Average	1.21	0.05	4.13
					1	1.16		
					2	1.26		
Seaweed	whole	raw	IN20		Average	28.36	1.01	3.57
				June 99	1st	28.71		
				Feb. 99	2nd	28.01		
Blueberry	berry	raw	IN92	June 99	Average	23.32	1.15	4.94
					1st	24.13		
					2nd	22.50		
Caribou	kidney	raw	IN29		Average	9.14	0.35	3.87
				Feb. 99	1st	8.89		
				June 99	2nd	9.39		
R. Seal	liver	raw	IN71	June 99	Average	21.14	0.13	0.64
					1st	21.23		
					2nd	21.04		
R. Seal	liver	raw	IN17	Feb. 99	Average	28.18	2.59	9.18
					1st	26.35		
					2nd	30.01		

13. Intake of Vitamin C among Inuit Women Aged 20-40 Years

13.1 Vitamin C Intake

Vitamin C intake of women aged 20 - 40 was determined for each bi-monthly data collection period over one calendar year. Summarized in Table 13.1 are the mean and standard deviation (SD) of the daily intakes of vitamin C per season presented for traditional(TF) and market food (MF) combined and separately. The contribution of vitamin C from MF was also analysed for the distribution of vitamin C between natural and fortified sources. Mean values were rounded to a whole number, rounding up if >0.51.

In each data collection period (season), as from section 9.1, the number of recalls varied between 31 and 38. There were 52 women who contributed 2 to 6 recalls. The means were adjusted for intra-individual variation and the unbalanced data across seasons. The adjusted means and their standard error (SE) are displayed in Table 13.2. Displayed in Figure 13.1 are the mean intakes of vitamin C across the seasons.

The adjusted seasonal daily mean intake of vitamin C for women 20 - 40 years was 60 ± 8 mg/day. As the data were highly skewed to the right, the measure of spread or variability of the distribution is presented in Table 13.3. In Figure 13.2, a bar chart displays the median intake and contribution from TF and MF food for each season. The median intake of vitamin C for this group was 30 mg in spring (March/April), 25 mg in late spring (May/June), and 20 mg in summer (July/August), rising to 38 mg in early fall (Sept/Oct), 41 mg in late fall (Nov/Dec) and 47 mg in winter (Jan/Feb). From this viewpoint, the data indicate that over the summer months, the majority of women are consuming less than 30 mg of vitamin C per day. As per Table 13.3, 25 % of women interviewed in each season obtained a level of vitamin C below 20 mg.

Due to the non-normal distribution of the data the means were log transformed prior to comparisons of the means for seasonal difference. There was no significant seasonal difference in the overall mean intake of vitamin C. There was significant seasonal variation ($p<0.02$) in the mean intake of vitamin C from traditional food (TF). A multiple comparison of the seasons was performed using Scheffe's test. The results indicated that there was significant seasonal variation in vitamin C intake from TF ($p < 0.03$) between early and late fall for this group.

The vitamin C intake of women for each season was compared to the Canadian Recommended Nutrient Intake (RNI) for this nutrient (Scientific Review Committee 1990). The percentage of women interviewed per season who obtained selected levels of the RNI and the relevant DRI's is summarized in Table 13.4. Notwithstanding the daily variability within and between individual intake for vitamin C, across the seasons 49 % of women were not meeting the RNI of 30 mg/day. The number of women interviewed per season who did not meet the RNI varied from 37 % in winter to 58 % in summer. A high percentage of women reported vitamin C intakes less than 50 % of the RNI.

In April 2000, the new Dietary Reference Intakes (DRI's) for vitamin C were announced by the Institute of Medicine (IOM), Washington, DC. The DRI's have been created to replace the Canadian RNI's and the United States RDA's and are part of an effort by the Canadian and American governments to harmonize nutrition recommendations. For women aged 20 - 40 years, the EAR for vitamin C is 60 mg/day and the RDA for vitamin C is 75 mg/day, a level expected to maintain maximum neutrophil concentration with minimum excretion of ascorbate (IOM 2000). For individual planning, the RDA should be used whereas for estimation from dietary surveys of group prevalence of inadequate intake, the EAR is to be used. Based on the levels of vitamin C as set by the DRI, between 17 % (summer) and 37 % (winter) of women interviewed in Qikiqtarjuaq obtained the RDA, whereas 28% (summer) and 37% (winter) of the group obtained the EAR. Only 8 % (summer) and 19 % (winter) of the women interviewed had intakes in excess of 110 mg/day. None exceeded the UL.

Although the incidence of smoking was not measured here, rates greater than 70 % have been reported for this age group of women on Baffin Island (Lawn *et al.* 1996). For smokers, the aim for individual intake is set at 50 % above the RDA (110 mg/day), however for smokers (as a group) an adjusted average requirement of 95 mg/day would be used to assess the likelihood of inadequacy of intake for females. Speculating that the rate of smoking in this age group is high in Qikiqtarjuaq, the percentiles indicate that between 45 % (winter) and 65 % (late spring) of women were not obtaining the EAR of vitamin C for smokers, suggesting that if 70% of the group do smoke, only a small portion of the group interviewed (20%) achieved adequate intake of vitamin C.

Table. 13.1 Mean Daily Vitamin C (mg ± SD) Intake from Traditional (T) and Market (M) Food and from Natural and Fortified Market Sources for Women Aged 20-40, Qikiqtarjuaq, 1987-1988

Food Source	Winter (n=38)	Spring (n=38)	Late Spring (n=31)	Summer (n=36)	Early Fall (n=34)	Late Fall (n=32)	Seasonal difference
T + M	67 ± 75	68 ± 83	59 ± 79	44 ± 56	66 ± 86	51±47	ns
Traditional	6 ± 16	14 ± 41	14 ± 39	8 ± 20	24 ± 50	10 ± 30	p<0.02
Market	61± 75	54 ± 78	45 ± 75	36 ± 56	42 ± 60	42 ± 42	ns
Fortified*	40 ± 72	36 ± 75	36 ± 72	24± 45	29 ± 58	24 ± 34	ns
Natural (Market only)	27 ± 22	18 ± 21	9 ± 13	12 ± 22	13 ± 19	17 ± 19	ns

*Fortified sources include evaporated milk, potato chips, fortified juice flavoured beverage powder, apple juice. Seasonal difference tested by use of Proc-Mixed Model on log-transformed data.

Table 13.2 Adjusted Mean Daily Vitamin C (mg ± SE) Intake from Traditional (T) and Market (M) Food of Women Aged 20-40, Qikiqtarjuaq, 1987-1988

Food Source	Winter (n=38)	Spring (n=38)	Late Spring (n=31)	Summer (n=36)	Early Fall (n=34)	Late Fall (n=32)	Season Average
T + M	66 ± 12	67 ± 12	57 ± 13	48 ± 12	66 ± 12	54 ± 13	60 ± 5
Traditional	6 ± 6	14 ± 6	14 ± 6	8 ± 6	24 ± 6	10 ± 6	12 ± 2
Market	61± 11	54 ±11	42 ± 12	39 ± 11	41± 11	44 ± 12	47 ± 6
Fortified*	40 ± 10	36± 10	33 ± 11	27 ± 10	28 ± 10	26 ± 11	32 ± 6
Natural (Market only)	21 ± 3	18 ± 9	9 ± 4	12 ± 3	13 ± 3	17 ± 4	15± 1

*Fortified sources include evaporated milk, potato chips, fortified juice flavoured beverage powder, apple juice. Means adjusted for intra-individual variation and unbalanced data across seasons.

Figure 13.1

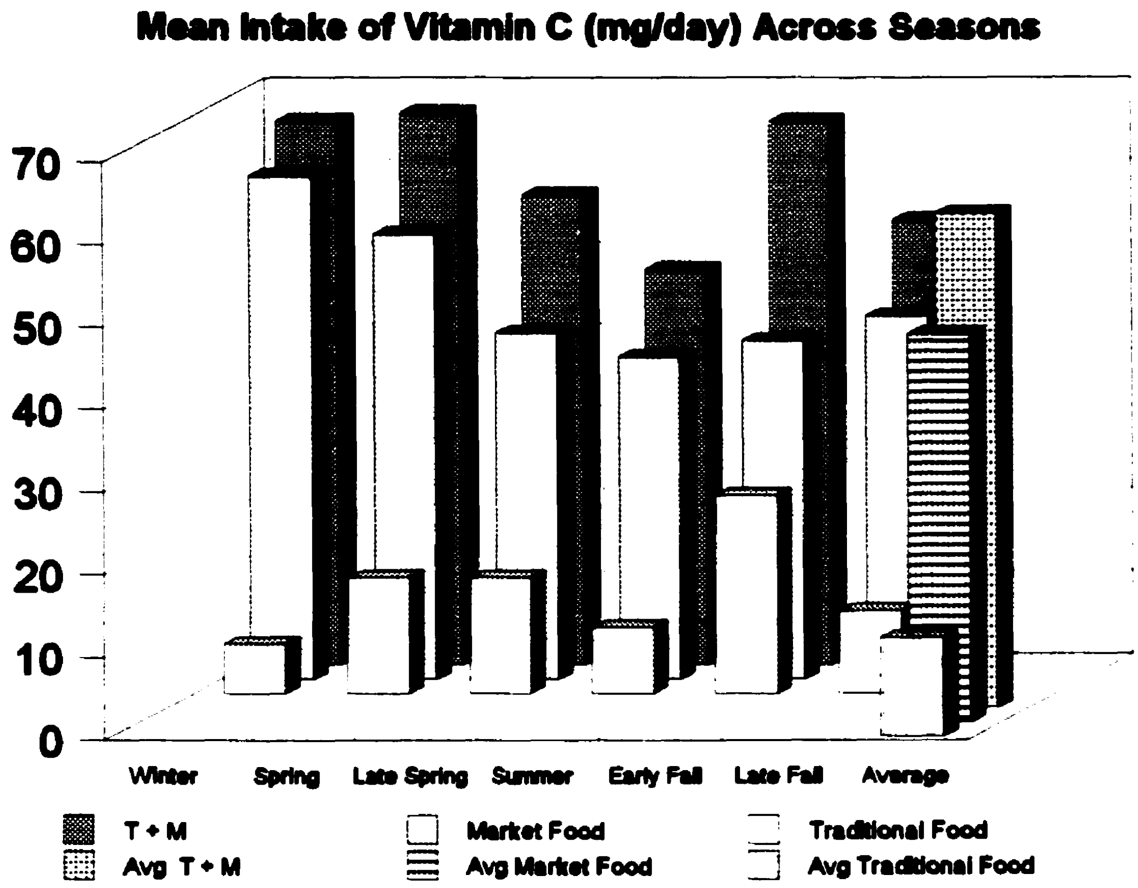

Mean Intake of Vitamin C (mg/day) Across Seasons
70
60
50
40
30
20
10
0
Winter
Spring
Late Spring
Summer
Early Fall
Late Fall
Average
T + M
Avg T + M
Market Food
Avg Market Food
Traditional Food
Avg Traditional Food

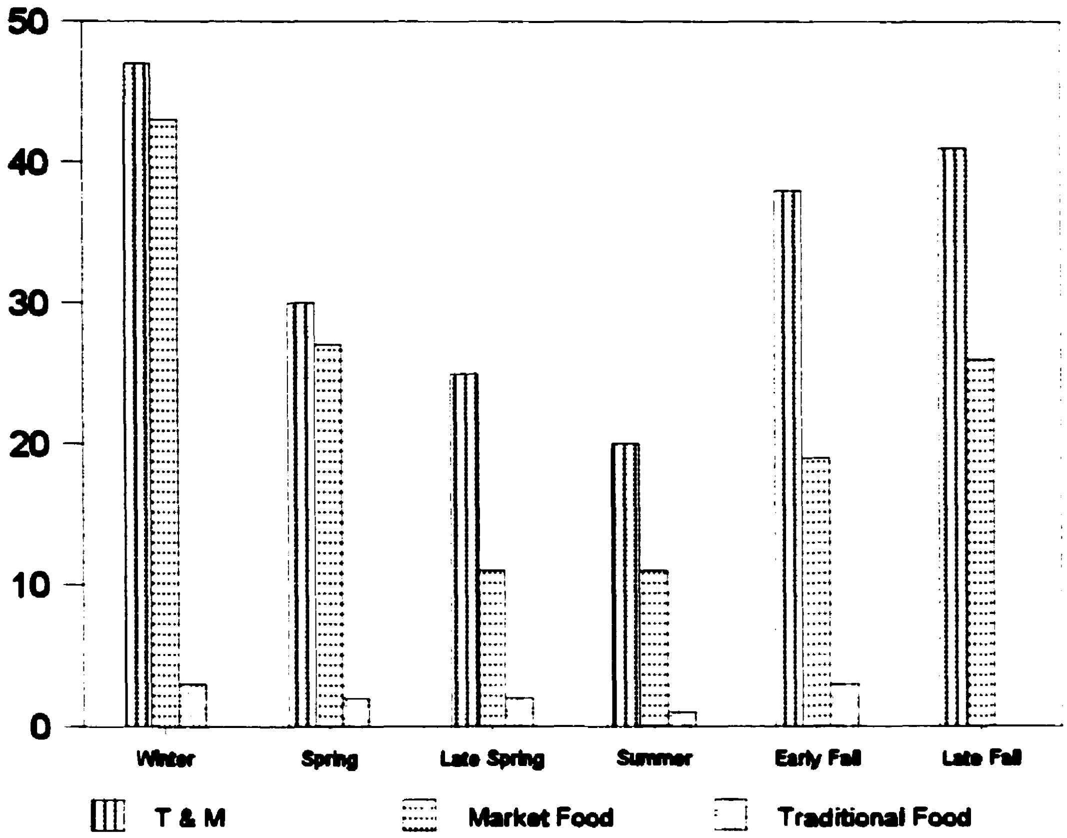
Table 13.3 Range of Total Vitamin C Intake (mg/day) among Women Aged 20 - 40						
Season	**n**	**Mean**	**Median**	**Quartile 1**	**Quartile 3**	**Max**
Winter	38	67	47	19	90	372
Spring	38	68	30	19	82	369
Late Spring	31	59	25	10	93	372
Summer	36	44	20	5	62	219
Early Fall	34	66	38	17	88	442
Late Fall	32	51	41	10	78	162

Table 13.4 Percentage of Women Interviewed per Season, Aged 20-40 Who Meet Selected % 1989 RNI (30 mg/day) for Vitamin C and the 2000 EAR (60 mg/day) and the 2000 RDA (75 mg/day) and the 2000 EAR for smokers (95 mg/day)

Season	<50 %	≥50% & < 75%	≥75% & <100%	≥100%	60 mg	75 mg	95 mg
Winter	24 %	8 %	5 %	63 %	37%	37 %	21%
Spring	24 %	5 %	21 %	50 %	37%	29 %	21%
Late Spring	42 %	3 %	10 %	45 %	32%	29 %	23%
Summer	42 %	11 %	5 %	42 %	28%	17 %	6%
Early Fall	21 %	12 %	15 %	53 %	38%	26 %	23%
Late Fall	28 %	3 %	12 %	56 %	34%	31 %	19%
Average	30 %	7 %	11 %	51 %	34%	28 %	20%

Women in this age group appear to consume an adequate level of vitamin C to prevent clinical deficiency, however the majority of women were not regularly obtaining the daily recommended levels of this nutrient as set by the 1989 RNI and the recently set DRI to achieve maximum reducing ability and reduce the risk of chronic disease. It is acknowledged that 24 hour recalls for a group are known to potentially underestimate energy by up to 30 %. However, the mean energy intake for this age group reported in previous papers was 2180 ± 705 kcal/day (Kuhnlein 1989), with more than 90% meeting the RNI for energy.

Figure 13.2 Median Intake of Vitamin C (mg/day) Among Women Aged 20 - 40



13.2 Contribution of Traditional Food Sources to Vitamin C Intake

TF was consumed by the majority of women interviewed in each season but due to the fair to poor sources generally chosen by the majority of TF consumers, it contributed only 20 % of the daily mean intake of vitamin C (Table 13.1, Table 13.2). The seasonal adjusted mean intake of vitamin C from TF was 12 ± 2 mg.

There was significant seasonal variation in the mean intake of vitamin C from TF sources between seasons of early and late fall. This difference can be attributed to the greater frequency and quantity of consumption of narwhal berries and kelp, which are rich sources of vitamin C, well liked and harvested in this period (Table 13.7).

In each season, the median intake of vitamin C from TF remained below

5 mg/100 g. The range of vitamin C intake from TF alone is summarized in Table 13.5.In Table 13.6 are described the number of women interviewed per season who obtained selected levels of vitamin C from intake of TF alone. With the exception of early fall, 25 % of the women interviewed per season obtained more than 5 mg/day from TF sources and less than 10 % of the group had usual vitamin C intakes in excess of 30 mg from TF sources. In early fall, due to the higher frequency and quantity consumed of TF that are good sources of vitamin C, 25 % of the women interviewed consumed obtain intakes in excess of 35 mg from TF sources. Based on the new RDA in comparison to the former RNI, only one TF consumer obtained 75 mg from TF during the winter. For each season, between one and three TF consumers obtained an intake in excess of 75 mg/day.

Table. 13.5 Range of Vitamin C Intake (mg/day) From Traditional Sources among Women Aged 20-40

Season	n	Mean	Median	Quartile 1	Quartile 3	Max
Winter	38	6	3	0	4	90
Spring	38	14	2	0	5	197
Late Spring	31	14	2	0	5	185
Summer	36	8	1	0	6	86
Early Fall	34	24	3	0	35	262
Late Fall	32	10	0	0	3	158

Although there are several good TF sources of vitamin C, 80 % of women aged 20-40 years obtain less than half of the RNI from TF sources. It appears that women in this age group usually consume small quantities of TF items such as meat, which contain low levels of vitamin C and/or consume richer sources of vitamin C too infrequently to be captured by the 24-hour recalls. From my own field work in Mittimatilik, organs of narwhal, such as the heart and liver and meat, were identified as consumed by an elder female and hunters but not among the younger women interviewed (20-60).

During most of the year, TF sources rich in vitamin C are available in the community (mattak, ringed seal liver, kelp). However, preference in taste may dictate that women consume mattak more frequently when it is fresh rather than stored. Similarly, berries and plants such as kelp may be preferred to be eaten during the season in which they are harvested rather than from stored frozen food. In the community of Mittimatilik, with respect to issues of food preferences, young women described a preference for TF that was 'fresh', meaning harvested recently for reasons of taste. The young people interviewed, unlike elders, were less likely to consume TF that had been stored for a period greater than three months.

Table 13.6 Number of Recalls per Season from Women, Aged 20-40 with Selected Levels of Vitamin C (mg) obtained from Traditional Food Sources

Season	n	< 10 mg	10 - 29 mg	30 - 59 mg	60 -74 mg	75 - 99 mg	≥ 100 mg
Winter	38	34	2	1	0	1	0
Spring	38	34	1	0	0	1	2
Late Spring	31	27	1	1	0	0	2
Summer	36	30	4	0	0	2	0
Early Fall	34	22	3	5	1	2	1
Late Fall	32	28	1	2	0	0	1

13.2.1 Primary Sources of Vitamin C from Traditional Food

It can be seen from the daily vitamin C intakes from Table 13.5 and Table 13.6 that a minority of TF consumers obtained levels of intake of vitamin C that surpassed the RNI. The TF which served as a source of vitamin C among these women would historically have been available in these seasons due to seasonal availability and/or usual storage practices. Although not captured in this data set, it is likely that historically, TF plants, which are often picked while walking through the summer months (July - October), would have been another rich source of vitamin C for part of the year and for some groups into winter. The use of seaweed over the winter has been recorded by early ethnographers among Inuit of Baffin Island and more recently in Borré (1994), elders originating from Cumberland Sound recalled storage of some plants over winter. All of the residents of Mittimatilik that

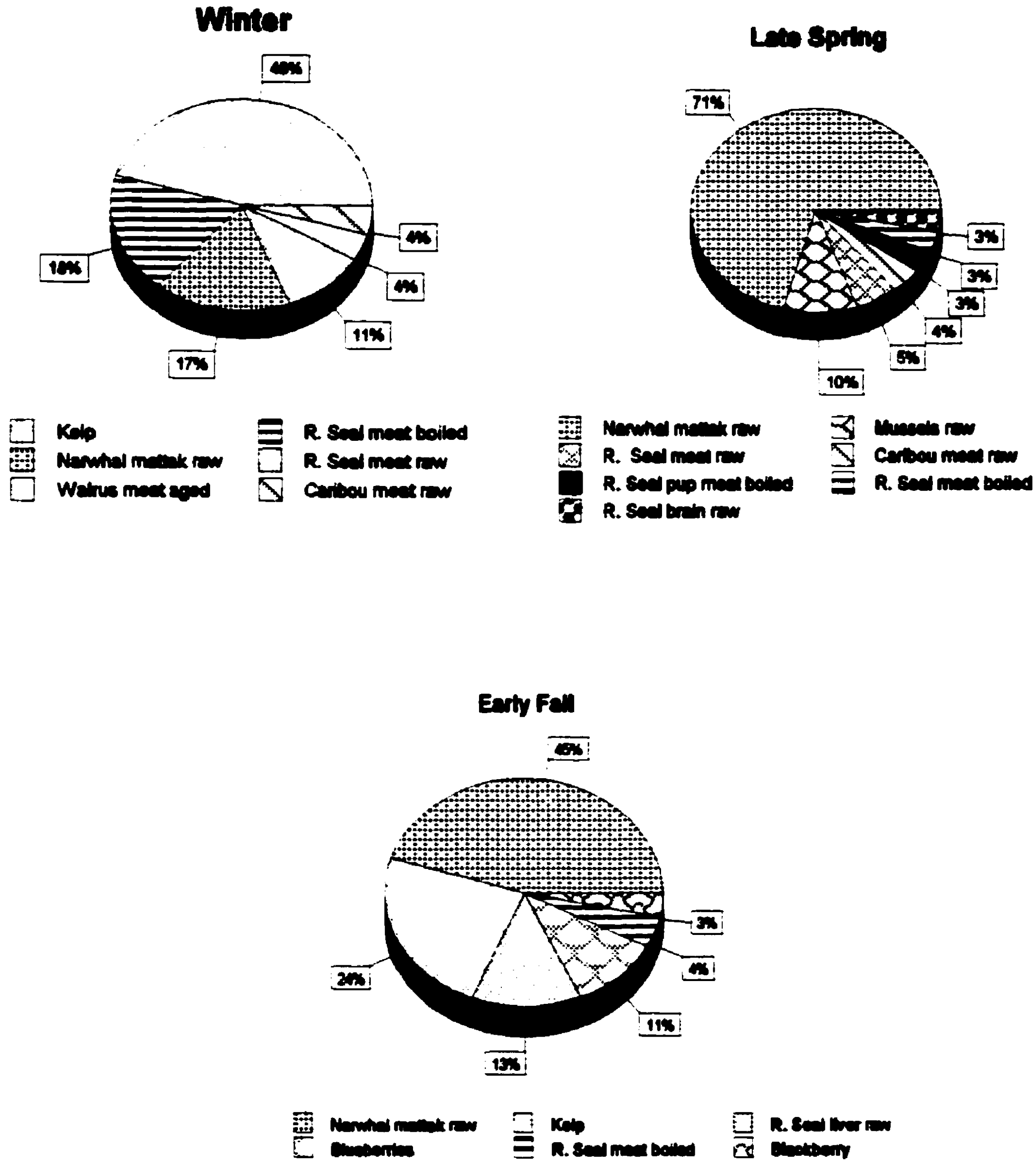
I talked with told me that today, roots are seldom collected for more than an occasional meal and other plants might just be eaten while walking.

The primary TF contributors of vitamin C are summarized in Table 13.7. In each season, only a few types of TF contributed more than 5 % of the total vitamin C from TF sources. Displayed in pie chart format in Figure 13.3 is the breakdown of the TF which contributed at least 3 % of the total vitamin C from TF in winter, late spring and early fall. Throughout all seasons, narwhal mattak was a major contributor of vitamin C from TF. At a minimum, narwhal mattak provided 27 % of the vitamin C from TF in summer (July/August) to a maximum of 82 % of the vitamin C from TF in early spring (March/April). The relative difference in contribution from narwhal mattak is a result of the infrequent or limited quantity eaten of other sources of vitamin C from TF during these months. During the winter (January/February), TF which contributed more than 5 % of the total vitamin intake from TF included kelp, raw and boiled ringed seal meat and raw narwhal mattak. In spring (March/April), historically a time when reliance still included remains of fall stores and freshly harvested seals, narwhal mattak and raw and boiled caribou meat were the primary contributors of vitamin C. In late spring (May/June), raw narwhal mattak, raw mussels and raw ringed seal meat contributed more than 5 % of the vitamin C from TF. In the summer (July/August), raw and boiled narwhal mattak, ringed seal meat boiled and raw, kelp and dried narwhal meat were the primary contributors of vitamin C. In early fall (Sept/Oct), raw narwhal mattak, kelp, raw ringed seal liver and blueberries were the TF contributors of vitamin C. In late fall (Nov/Dec), boiled narwhal mattak and raw and boiled ringed seal meat were the primary contributors of vitamin C from TF.

Table 13.7 Traditional Food Contributors of Vitamin C - Percentage (%) of Total Vitamin C Contributed from Selected Traditional Food Sources and Frequency of Use (F) per Season by Women Interviewed

Winter			Early Spring			Late Spring			Summer			Early Fall			Late Fall		
	F	%		F	%		F	%		F	%		F	%		F	%
Kelp	2	43	Narwhal mattak, raw	3	82	Narwhal mattak, raw	2	65	Narwhal mattak, raw	1	27	Narwhal mattak, raw	5	42	Narwhal mattak, raw	3	72
R. Seal meat, boiled	11	17	Caribou meat, raw	17	11	Mussels, raw	1	9	Narwhal mattak, boiled	1	27	Kelp	4	22	Narwhal mattak, boiled	1	17
Narwhal mattak, raw	1	16	Caribou meat, boiled	15	6	R. Seal meat, raw	3	5	R. Seal meat, boiled	10	13	R. Seal liver, raw	2	12	R. Seal meat, boiled	4	8
R. Seal, meat raw	6	10	R. Seal meat, boiled	1	1	Caribou meat, raw	6	4	R. Seal meat, raw	3	9	Blueberries	2	10	R. Seal meat, raw	1	1
Walrus meat, aged	3	4				R. Seal pup meat, boiled	4	3	Kelp	1	7	R. Seal meat, boiled	6	4	A. Char meat, raw	1	1
Caribou meat, raw	3	4				R. Seal meat, boiled	4	3	Narwhal meat, dried	3	5	Blackberry	5	3			
Walrus meat, raw	1	2				R. Seal brain, raw	1	3	Caribou meat, raw	2	4	R. Seal meat, raw	4	2			
A. char meat, boiled	2	1				A. Char meat, boiled	3	2	A. Char meat, boiled	3	3	Narwhal mattak, boiled	1	1			

Figure 13.3 Primary Traditional Food Contributors of Vitamin C in Winter, Late Spring and Early Fall



13.3 Contribution of Market Food to Vitamin C Intake

Store food provides the majority of energy and vitamin C in the diet of these Inuit women. The mean intake/day of vitamin C from MF was 47 ± 6 mg. As shown in Table 13.8 in which the range of vitamin C intake from market sources is summarized, 25 % of the women interviewed per season obtained less than 10 mg/day from MF. This low level of intake of vitamin C is not generally compensated by a higher intake from TF. The median intake of vitamin C from MF was below 20 mg during the seasons of late spring, summer and early fall and above 25 mg in late fall, winter and spring.

13.3.1 Contribution from Natural and Fortified Sources and Supplements

Over 50 % of the mean intake of vitamin C across the seasons was obtained from a handful of fortified products available in the community. The daily mean intake of vitamin C from fortified sources was 32 ± 6 mg or 65 % of the contribution from MF. The mean intake of vitamin C from natural sources of this nutrient in MF was 15 ± 1 mg. Natural sources from both TF and MF provided a similar mean intake of vitamin C across the seasons. Supplements were not used by any of the women in this group. Relatively speaking, although the levels of intake of vitamin C are low among members of this group, fortified food sources serve as the primary contributors of vitamin C among this group in the absence of low intake of good traditional sources of vitamin C.

13.3.2 Primary Sources of Vitamin C from Market Food

The primary MF sources of vitamin C are fortified food items. The top source across the seasons was fortified fruit beverage powder which contributed 40 % of the MF source of vitamin C. Only four to six food items recalled per season provided a minimum of 5 % of the total vitamin C from MF. The primary contributors of vitamin C from MF are summarized in Table 13.9. The various food items were summed per season for their contribution to the total vitamin C from MF and then displayed with their percentage contribution to the total and frequency of use. In each data collection period, between 10 - 32 % of women recorded the use of fortified juice beverage powder. Similarly, between

30 - 40 % of the women recorded the use of evaporated canned milk. With respect to fruits and vegetables, potatoes (chips, boiled, fries) were the main contributors of vitamin C. Potato chips were recalled by 12-23 % of the women interviewed per season. Apple juice in each season contributed a significant amount of the vitamin C from MF but it is an item recalled by not more than 5 % of the women interviewed per season. The major sources of vitamin C in Inuit communities are unlike those commonly used in the southern part of Canada and the U.S., namely citrus fruits.

Table 13.8 Range of Vitamin C Intake from Market Sources (mg/day) among Women Aged 20 - 40

Season	n	Mean	Median	Quartile 1	Quartile 3	Max
Winter	38	61	43	10	90	372
Spring	38	54	27	8	65	365
Late Spring	31	45	11	0	58	370
Summer	36	36	11	2	45	217
Early Fall	34	42	19	4	59	250
Late Fall	32	42	26	5	74	139

Table 13. 9 Market Food Contributors of Vitamin C - Breakdown of Percentage (%) of Total Vitamin C from Market Food Sources and Frequency of Use (F) per Season by Women Interviewed (Food Items Fortified are noted by *)

Winter			Early Spring			Late Spring			Summer			Early Fall			Late Fall		
Food	F	%		F	%		F	%		F	%		F	%		F	%
Juice crystals*	12	47	Juice crystals*	6	29	Juice crystals*	6	39	Juice crystals*	3	28	Juice crystals*	8	58	Juice crystals*	8	40
Spaghetti -meat, tom.	5	9	Potato chips*	9	18	Apple juice*	2	25	Potato chips*	6	19	Potato - fries	5	7	Spaghetti-meat, tom.	4	10
Milk evap. cnd*	11	8	Apple Juice*	1	12	Milk evap. cnd*	12	9	Milk evap. cnd*	13	13	Milk evap. cnd*	14	6	Milk evap. cnd*	13	8
Cabbage raw	3	6	Beef & Veg stew	4	8	Potato chips*	7	8	Orange juice frozen	1	7	Potato chips*	4	5	Apple juice*	1	7
Potato chips*	6	5	Orange juice frozen	1	4	Beef & Veg stew	2	5	Apple juice*	1	6	Cabbage raw	1	4	Beef & Veg stew	3	6
Apple juice*	2	5	Pizza w. Cheese	4	4	Tomato - cnd	2	3	Spaghetti - meat, tom	2	5	Chicken cnd	7	3	Potato - mashed	7	5
Potato - fries	4	4	Milk evap. cnd*	10	3	Potatoes boiled	4	2	Orange raw	1	4	Spaghetti cnd -tom	2	3	Orange raw	1	4
Beef & Veg stew	4	3	Chicken cnd	9	3	Tomato - Ripe	3	2	Pineapple raw	1	3	Beef & Veg. stew	1	2	Potato chips*	2	3
Orange raw	1	2	Potato - mashed	3	2	Soup - tomato	3	2	Potato -fries	1	3	Frozen dinner	2	2	Potato - fries	4	2

13. 4 Analysis of Vitamin C Intake among Women, 1998-1999

The community of Qikiqtarjuaq participated in a survey conducted in 18 communities "Assessment of Dietary Benefit: Risk in Inuit Communities" (Kuhnlein *et al.* 1999). As part of the survey, twenty-four hour recalls were obtained from women aged 20 - 40 years in Qikiqtarjuaq during Fall of 1998 (October/November)(n=13) and early spring (February/March) of 1999 (n=10). Due to the small sample size in each season of non-pregnant, non-lactating women the mean intake of vitamin C was calculated from the total number of recalls (n=23).

The energy and vitamin C intake of this group are summarized in Table 13.10 below. The distribution of vitamin C intake was skewed to the right. The median intake was 24 mg/day, falling well below the 1990 RNI and 2000 EAR. MF continues to provide the majority of the daily vitamin C intake. Fourty-eight percent of the group obtained a vitamin C intake ≥RNI and only 35% of the group had a vitamin C intake ≥EAR, suggesting that women in this age group are not achieving an adequate intake for this nutrient. Nine percent of the group obtained an intake above the EAR from traditional food sources alone and 26% achieved an intake above the EAR from market food alone. The intake of vitamin C from MF was not broken down into natural and fortified sources, however there were 10 mentions of the use of non-fortified juice crystals (Koolaid), 2 mentions of orange juice and no mention of fortified juice crystals.

Table 13.10 Energy and Vitamin C Intake of Women (N=23) Aged 20 - 40, Qikiqtarjuaq 1998 - 1999

Nutrient	Food Source	Mean	SD	SE	Median
Energy (kcal/day)	Traditional + Market	1798	1014	211	1542
	Traditional	555	1006	210	0
	Market	1242	819	171	1111
Vitamin C (mg/day)	Traditional + Market	49	44	9	24
	Traditional	11	30	6	0
	Market	38	41	9	19

14. Historical Intake of Vitamin C by Inuit

14.1 Dietary Reconstruction of Pre-contact Diet and Vitamin C Intake

For the following estimates of pre-contact vitamin C intake the macronutrient ratio and energy level were kept constant. A protein/fat /carbohydrate ratio of 45:49:6 based on an estimate from Rabinowitch & Smith (1936) was selected and converted to an expected gram weight basis for a diet set at a level of 2500 kilocalories, a reasonably assumed minimal level to support adults and growing children engaged in daily physical activity.

Historically, a diet containing 2500 calories and a protein/fat/CHO ratio of 45:49:6 would be equivalent to a weight of 1100 g (meat/organs), 133 g (blubber/fat) and 100 to 300 g of plants. These calculations converted into gram weight are based on food composition data (Kuhnlein & Soueida 1992). This weight level seems reasonable. Binford (1974) calculated that average intake of meat and organs by Nunamiut Eskimo was 1100 g/day. It is likely that average kilocaloric levels would approach higher levels. Hoygaard (1941) calculated an average of 2800 kilocalories for Angmagssalik Inuit, noting a range from 1500 kilocalories during lean times in February to greater than 3500 kilocalories during November (stored food) and March (beginning of sealing). Rabinowitch & Smith (1936) estimated that for Inuit of the eastern Arctic (data compiled from Hudson Strait, Ellesmere Island and Northern Baffin Island Inuit) in times of abundance, daily intakes of lean meat were in excess of 2 kg, suggesting either variation in the estimated ratio or range in total kilocalories.

From the data in the following sections, one can calculate the 'relative' importance of each arctic species based on edible total meat weight and kilocaloric availability per species. However, this does not provide information as to the actual amount of each species eaten on a seasonal or daily basis. It is likely that in each season, one or two animal species contributed the majority of kilocalories and therefore bulk of the food weight. For the purposes of estimations of a historical intake, the percentage of total weight or kilocalories that each species contributes to the diet as per the data provided, was converted to an equivalent percentage in terms of a diet that contained 1100 g (meat/organs). For example, if ringed seal contributes 23 % of the total edible meat, this was converted to a daily weight basis of 253 g of meat/organs. For the purposes of this model, it was assumed that the percentage of kilocalories/species does not account for energy from fat. This assumption allowed ease of calculation and a conservative estimate of a minimum level of vitamin C. For animals that make up < 5 % of the overall diet in terms of edible meat, this method of calculation will underestimate vitamin C intake, particularly with respect to seasonal use.

In Table 14.1 are the assigned values of vitamin C/species. Vitamin C calculations per species were based on weight of parts eaten multiplied by the mean level of vitamin C found (mg/100 g) which were then summed and expressed as mg/kg. In some cases for particular species, there were two potential vitamin C levels/kg derived and used in calculations on the basis of information from harvest utilization studies. Regarding the calculated level of vitamin C in beluga and narwhal, imputed values were obtained from ringed seal for liver, bearded seal for stomach and caribou for heart. Differences in potential weight and vitamin C per species include preferential use of younger animals for human consumption and the use of animals for dog food. The division of an animal into parts for human and dog use would have been very relevant in the past.

Table 14.1 Vitamin C Value /Species (mg/kg)

Fauna	Wt (kg)	Parts include	Vitamin C mg/kg
R. Seal	20	meat, liver, heart, eyes, brain, intestines	56 mg/kg
	14	meat	16 mg/kg
B. Seal	73	meat, heart, intestines	19 mg/kg
	37	meat, heart, intestines	22 mg/kg
Seal	·	meat	16 mg/kg
Beluga	77	mattak	360 mg/kg
	270	meat, mattak, heart, liver, intestines	122 mg/kg
Narwhal	77	mattak	310 mg/kg
	270	meat, mattak, heart, liver, intestines	115 mg/kg
Polar Bear	45-165	meat	10 mg/kg
Walrus-adult	285	meat, heart, liver, intestines	24 mg/kg
	60	meat, heart, liver, intestines	77 mg/kg
Walrus -subadult	93	meat, heart, liver, intestines	53 mg/kg
	61-239	meat	10 mg/kg
Caribou	30	meat, heart, liver, tongue, kidney, stomach	20 mg/kg

14.2 Ethnographic Data

Building a historical model is a complex task given the sparsity of ethnographic information and lack of quantifiable information on relative importance of species prior to the traditional-contact period. Boas (1964 [1888]) wrote that ringed seal provided the majority of kilocalories in the early 1880's but that prior to whaling, the contribution to kilocalories from bowhead whales for Inuit inhabiting Cumberland Sound and from beluga and narwhal on the east coast of Baffin Island may have been greater.

Assuming only consumption of the ringed seal in a day, minimal potential vitamin C levels obtained on a 100 g basis range from 1.6 mg/100 g (meat alone) to 5.6 mg/100 g (meat +organs). On a diet containing 1100 g of meat on a daily basis, this would translate to a range of 17- 62 mg of vitamin C based on consumption of seal alone.

In winter months, seal and stored foods from fall hunts were the prime food sources for the Inuit. The stored food would have consisted of whale and walrus meat and organs including mattak. Additionally plant food such as seaweed was often available in coastal villages. It is quite reasonable to suggest that a winter diet would consist of seal and small quantities of mattak and seaweed. For a diet containing 1000 g of ringed seal meat, 100 g of mattak and 100 g of plant material such as seaweed, in winter vitamin C intake could approach a range of 47 - 105 mg. (The minimum calculated level of vitamin C is based on a diet of boiled ringed seal meat and mattak whereas the upper value is for consumption of ringed seal meat and organs (5.6 mg/100 g) and raw mattak (31.5 mg/100 g).)

The assumptions about vitamin C intake over the winter fit in well with Matthiasson's (1992) description of life in a winter camp. In the early 1960's, Matthiasson spent winter camping with the Tununirmiut in northeastern Baffin Island. Over the winter, reliance was on ringed seal. During the winter of 1963, Matthiasson recorded that two ringed seal were obtained weekly for each household (5 - 8 people). Parts eaten included the meat and organs. During the transition from winter to spring, there was a decline in hunting during the last months. In this time reliance turned to cached meat and narwhal mattak. Based on Matthiasson's description of the winter period, fresh ringed seal was abundant in households in the early winter months. Based on the quantity of ringed seal available per person/day of 0.9 kg, assuming an average household size of 6.5 people and an edible weight of 20 kg/ringed seal, the daily vitamin C intake would approach 50 mg/day from ringed seal alone. Borré (1991) recorded that a common dish prepared in Clyde River consisted of stew made of the meat, organs and blood of ringed seal. Given the descriptions from Matthiasson and Borre, it is probable that in the past a greater quantity and variety of parts of harvested animals were consumed on a more frequent basis, elevating the intake of vitamin C.

Returning to the literature, I obtained information from two studies which estimated the relative importance of animal and plant species among coastal Inuit in terms of kilocalories on an annual basis. The estimations were converted as outlined above to obtain a potential vitamin C value. The results from Kemp (1971) and Hoygaard (1941) are displayed in Table 14.2. The range of vitamin C based on a diet containing 1100 g of meat/organs and 100 g of plant material is 20 - 113 mg/day. The range reflects calculations of inclusion of meat only in the calculation or meat and organs and variation in vitamin C content of plants available (4 - 40 mg) (Table 12.1, Appendix B).

Kemp (1971) conducted field research in an outpost camp with 29 inhabitants near Lake Harbour, Baffin Island, from 1967-68. At the time of his work, from his estimates, Traditional food (TF) accounted for 63 % of the overall calories. The main store foods in use consisted of flour, lard, tea, pop. Kemp estimated that on an annual basis in terms of kilocalories from TF; ringed seal provided ~63 %, bearded seal 11 %, whale 8 %, caribou 4 %, arctic char 3 %, eider duck 4 %, duck eggs 3 % and other (plant/shellfish) the remainder. Char, birds, shellfish and plants were primarily consumed from April to October.

Among the Angmagssalik of Greenland, Hoygaard (1941) recorded that mammals, primarily seal (fresh) contributed 80 % of the total kilocalories from TF with 57 % from fresh food and 23 % from stored (aged and frozen) foods. Fish contributed 17 %, birds 1 % and plants 2 % of the total kilocalories from TF.

As outlined above, the percentage of kilocalories that each species contributed was converted to a gram weight basis for a diet consisting of 1100 g of meat and organs. For the purposes of this model, it is assumed that the percentage of kilocalories/species does not account for energy from fat.

Table 14.2 Range of Vitamin C Potential Intake (mg/day) For a Diet Containing Meat Alone or Meat + Organs, Based on Ethnographic Data

Kemp (1971)				Hoygaard (1941)			
Fauna	% of diet	Wt (g)	Vitamin C/day	Fauna	% of diet	Wt (g)	Vitamin C/day
R. Seal	63	700	11 - 39	Seal	80	900	14 - 50
B. Seal	11	125	3				
Whale	8	90	10 - 28				
Caribou	4	45	0.5 - 1				
Arctic char	3	35	0.5	Fish	17	190	2
Eider duck	4	45	0.5	Birds	1	10	0
Duck eggs	3	35	0				
Shellfish	2	25	0.9				
Plant	2	100	4 - 40	Plant	2	100	4 - 40
Total			**30 - 113 mg**	**Total**			**20 - 92 mg**

14.3 Vitamin C Estimate from Harvest Data

Edible weight was calculated per species based on harvest data taken from Foote (1967). This edible weight only includes the quantity of meat and organs expected to be consumed. The edible weight per animal is the assumed minimum and maximum amount of meat alone or meat and organs that may be consumed based on Table 10.2 and Table 14.1. Similarly, a range of potential vitamin C/ kg is given based on calculation of meat or meat and organ per kilogram. The range of total weight from the harvest data was expressed on a per capita basis assuming normative and equivalent consumption across all residents (children /adults). During the period of harvest data collection, there were 209 residents at Qikiqtarjuaq.

The calculations for a pre-contact vitamin C intake estimated from harvest data from 1965- 1966 are summarized in Table 14.3. Based on the quantity of animals harvested/species, a minimum and maximum edible weight/capita/day was calculated for

TF from animal sources alone. During 1965- 1966, as per the harvest data, the vitamin C potential intake/capital/day from TF alone was 11 mg/day (0.69 kg) to 53 mg/day (0.96 kg). To calculate a historical intake of TF and vitamin C intake, it was assumed that the per capita/availability of TF would have been higher prior to the inclusion of market food (MF) in the diet. Assuming that the relative harvest and contribution of each species to the total edible weight was similar for a historical diet, the total edible weight was inflated to 1100 g/capita/day. In the last column of Table 14.3 is the expected range of vitamin C for a diet containing 1100 g of meat and organs. From the calculations, the minimum vitamin C intake was 17 mg/day and the maximum intake of vitamin C from animal sources alone was 58 mg/day. Given the likely minor consumption of plant food in the diet on a daily basis (100 g), usual intake would approach 19 - 98 mg/day.

Table 14.3 Potential Pre-contact Vitamin C Intake Calculated from Qikiqtarjuaq Harvest Returns 1965-66

Fauna	Quantity	Edible Wt/species (kg)	Vitamin C mg/kg	Total Weight (kg)	Vitamin C (mg/day)	Vitamin C (mg/day) for a diet of 1100 g
R. Seal	3469	14 - 20	16 - 50	48566-69380	10 - 53	15 - 52
Harp Seal	6	34 - 44	16 - 50	204 - 264	0.0 - 0.2	0.1 - 0.2
B. Seal	10	37 - 73	22 - 19	680 - 730	0.1 - 02	0.3 - 0.2
Walrus	2	60 - 285	77 - 24	370 - 730	0.4 - 0.2	0.6 - 0.3
Polar bear	26	45	10	1170	0.2	0.2
Caribou	50	30	20	1750	0.5	0.5
				52492 - 73573		
		Minimum		0.69 kg/capita/day	11 mg/day	17 mg/1100 g
		Maximum		0.96 kg/capita/day	53 mg/day	58 mg/1100 g

Harvest returns obtained from Foote (1967).

14.4 Vitamin C Estimate from the Archaeological Record

The archaeological record can provide us with a sense of relative contribution of animals to the diet in a very generalized manner, given that information on diet is gained from faunal assemblages. Generally, it cannot provide us with relative seasonal use of animals, or yearly harvests but rather a scale of relative importance.

Faunal remains at sites can over or under represent relative importance of species. The remains represent species or animal parts with bones brought back to winter houses but not summer camps. For some mammals such as narwhal, the butchered portions returned to the village site may have only included those parts to be eaten, that is meat and organs such as the skin. In his journal Freuchen (1935) offers a few insights about the possible lack of remains of larger mammals at a winter village site. The first story is about the capture of a bowhead whale at Resolute Bay. After the whale was brought in there was a feast in which everyone ate as much mattak as they could. The following day people worked on butchering the whale, removing mattak, blubber and meat for their winter supplies. Unfortunately, the whale wasn't secured and by the next day the carcass had disappeared. In another story, northern Baffin Island Inuit told Freuchen about the loss of narwhals in Admiralty Inlet. According to his informants, they had completed the butchery of many narwhal on the ice prior to returning to camp when a storm occurred. The ice on which the narwhal skin, meat and blubber were being stored broke away and were lost to the Inuit but enjoyed by the polar bears. Both of these stories indicate a custom of often butchering the whale and leaving the bones or remains away from village and camp sites.

Data from prehistoric Thule sites in Savelle (1994) and a historic Thule from Sabo (1981) were transformed from Minimum Number of Individuals present (MNI) to edible weight values per individual based on information from Table 14.1, Freeman (1970), Riewe (1977) and Sabo (1981) to arrive at a likely percentage and relative contribution of the various animals in the diet. Calculations are summarized in Tables 14.4 through Table 14.6. Due to the subjectivity about the proportion of food from each animal used for human or dog use, the percentage of total meat/species was calculated in two ways. In Table 14.4, the usable meat/species is based on the assumption that most of the meat was eaten by humans. In Table 14.5, the usable meat/species available was adjusted downward due to allowance for dog food. In Table 14.6, usable meat/individual was calculated as in Table 14.4 and 14.4 as only the MNI from one site was assessed. Although bowhead bones may be present at Thule sites, their remains are not included in the data sets from the literature. The reason for their lack of inclusion appears to be due to the frequent assumption by archaeologists that the bones used in house structures were obtained from scavenging and not active hunting, although Savelle & McCartney (1988) argue against this assumption.

According to Damas (1984) and Savelle & McCartney (1988) the maximum residential winter populations of early historic Inuit, at each site was 100 individuals. From the number of dwellings seen at archaeological sites, Savelle calculated that there would be 5 - 8 individuals per dwelling (Savelle & McCartney1988). Taking this range of individuals as the norm per site, we could estimate from the total weights in Table 14.5 that for a household of 8 individuals, potentially there would have been enough meat and organs (not including energy from fat) for 10 - 12 months.

Vitamin C calculations per species are based on values in Table 14.1. From Table 14.4 and Table 14.5 which summarize the minimal and maximal range of vitamin C intake from data found in Savelle (1994), the vitamin C available/person/day was calculated between 32 - 63 mg from animal sources alone. In Table 14.6, the range of vitamin C intake/person/day calculated from the data set of Sabo (1981) was 17 - 38 mg. In both data sets, ringed seal predominated. As stated before, these calculations may overestimate the relative contribution of smaller fauna which were brought back to the village complete. These data do not include an estimation of vitamin C from plant matter.

Table 14.4 Vitamin C Intake Calculations from MNI Conversion to Percentage of Total Edible Weight Based on Maximum Edible Weight/Species (kg)

Developed and Classical (1100 - 400 BP) winter Thule Sites on Baffin Island (Savelle 1994)

Animal	Cumberland Sound site (Schlederman 1975) MNI	Peale Pt. site (Stenton 1983) MNI	Talaguak site (Sabo 1981) MNI	Edible Weight/ Individual (kg)	Edible Weight/ Species (kg)	Percentage of Total Weight	Vitamin C available /person/day /1100 g
Beluga	2	4	2	270	540 - 1080 - 540	16 - 11 - 8	21 - 15 - 11
Narwhal	-	1		270	- - 270 - -	0 - 3 - 0	0 - 4 - 0
R. Seal	92	191	112	20	1840 - 3820 - 2240	56 - 40 - 33	34 - 25 - 10
Harp Seal	7	17	-	44	308 - 748 - 0	9 - 8 - 0	5 - 4 - 0
B. Seal	4	13	10	73	292 - 949 - 730	9 - 10 - 11	2 - 2 - 2
Walrus	-	3	6	285	- - 855 - 1710	0 - 9 - 25	0 - 2 - 7
Caribou	5	43	28	30	150 - 1290 - 840	5 - 14 -12	1 - 4 - 4
Polar Bear	1	3	5	165	160 - 480 - 800	5 - 5 - 12	0.5 - 0.5 - 1
Fox	-	14	8	1.6	- - 22.4 - 12.8	0 - 0.2 - 0.2	0 - 0 - 0
Wolf	-	1		10	- - 10 - -	0 - 0.1 - 0	0 - 0 - 0
Arctic Hare	1	1	2	1	1 - 1 - 2	0.03 ——	
Birds	1	9	11	0.5	5 - 4.5 - 5.5	--- --- ---	
Total					**3293 - 9530 - 6878**		**63 - 57 - 44 mg**

Table 14.5 Vitamin C Intake Calculations from MNI Conversion to Percentage of Total Edible Weight Based on Minimal Edible Weight/Individual (Adjusted For Dog Use) (kg)

Developed and Classical (1100 - 400 BP) winter Thule Sites on Baffin Island in Savelle (1994)

Animal	Cumberland Sound site (Schledermann 1975) MNI	Peale Pt. (Stenton 1983) MNI	Talaguak (Sabo 1981) MNI	Edible Weight/ Animal (kg)	Edible Weight/ Species (kg)	Percentage of Total Weight	Vitamin C available/person day / 1100 g
Beluga	**2**	**4**	**2**	**77**	**154 - 308 - 154**	**8 - 5 - 4**	**32 - 20 - 16**
Narwhal	**-**	**1**		**77**	**0 - 77 - 0**	**0 - 1 - 0**	**0 - 3 - 0**
R. Seal	**92**	**191**	**112**	**14**	**1288 - 2674 - 1568**	**63 - 45 - 41**	**11 - 8 - 7**
Harp Seal	**7**	**17**	**-**	**34**	**238 - 578 - -**	**12 -10 - 0**	**2 - 2 - 0**
B. Seal	**4**	**13**	**10**	**37**	**148 - 481 - 370**	**7 - 8 - 10**	**1 - 1 - 2**
Walrus	**-**	**3**	**6**	**61**	**- - 183 - 366**	**0 - 3 - 10**	**0 - 0 - 1**
Caribou	**5**	**43**	**28**	**30**	**175 - 1505 - 980**	**8 - 25 - 25**	**2 - 6 - 6**
Polar Bear	**1**	**3**	**5**	**45**	**45 - 135 - 225**	**2 - 2 - 6**	**0 - 0 - 0**
Fox	**-**	**14**	**8**	**1.6**	**- - 22 - 13**	**0 - 0 - 0**	**0 - 0 - 0**
Wolf	**-**	**1**		**10**	**- - 10 - -**	**0 - 0 - 0**	**0 - 0 - 0**
Arctic Hare	**1**	**1**	**2**	**1**	**1 - 1 - 2**	**0 - 0 - 0**	**0 - 0 - 0**
Birds	**1**	**9**	**11**	**0.5**	**1 - 5 - 6**	**0 - 0 - 0**	**0 - 0 - 0**
Total					**2049 - 5978 - 3848**		**48 -40 - 32 mg**

Table 14.6 Vitamin C Intake Calculated from Conversion Of MNI to Percentage of Total Edible Weight Based on Minimum and Maximum Edible Weight/Species (kg)

Historic Thule (400 - BP) sites in Lake Harbour region from Sabo (1981)

		Minimum				Maximum			
Animal	MNI	Edible Weight per Individual	Edible Weight per Species	% of Total Weight	Amount of Vitamin C per day	Edible Weight per Individual	Edible Weight per species	% of Total Weight	Amount of Vitamin C per 1100 g
R. Seal	77	14	1078	51	9	20	1540	42	26
B. Seal	9	37	333	16	3	73	657	18	4
Walrus	3	61	183	9	1	285	855	23	6
Caribou	13	30	390	19	4	30	390	11	2
Polar Bear	1	45	45	2	0	165	165	4	0.4
Fox	5	1.6	8	0	0	1.6	8	0	0
Wolf	6	10	60	2	0	10	60	1	0
Arctic Hare	1	1	1	0	0	1	1	0	0
Birds	4	0.5	2	0	0	0.5	2	0	0
Total			**2100 kg**		**17 mg/day**		**3676 kg**		**38 mg/day**

14.4 Estimate of Vitamin C from Current Food Use

The top 30 TF ranked by fresh weight from the Qikiqtarjuaq data set (Appendix A) were used to estimate a potential pre-contact intake of vitamin C. The food items were converted to a percentage of the total weight contributed by this set of TF. Following this step, it was assumed that the percentage of total weight per food could be calculated into a corresponding gram weight basis for a total intake of 1100 g as done for previous estimates. A vitamin C level per food was calculated based on mean values of vitamin C per TF analysed in this thesis and from the literature. Based on this method, consumption of 1100 g of meat and organs would provide 38 mg of vitamin C/day. From this list of food items, plant sources provided an additional 9 mg, bringing the total potential daily intake of vitamin C to 47 mg/person/day.

14.5 General Statements About Calculations of Pre-Contact Vitamin C Intake

These calculations of a historical intake for vitamin C provide a conservative annual intake. As the TF analysed for this project contained a usual minimal level of 1 mg/100 g, a diet adequate in energy would contain sufficient vitamin C to prevent overt deficiency.

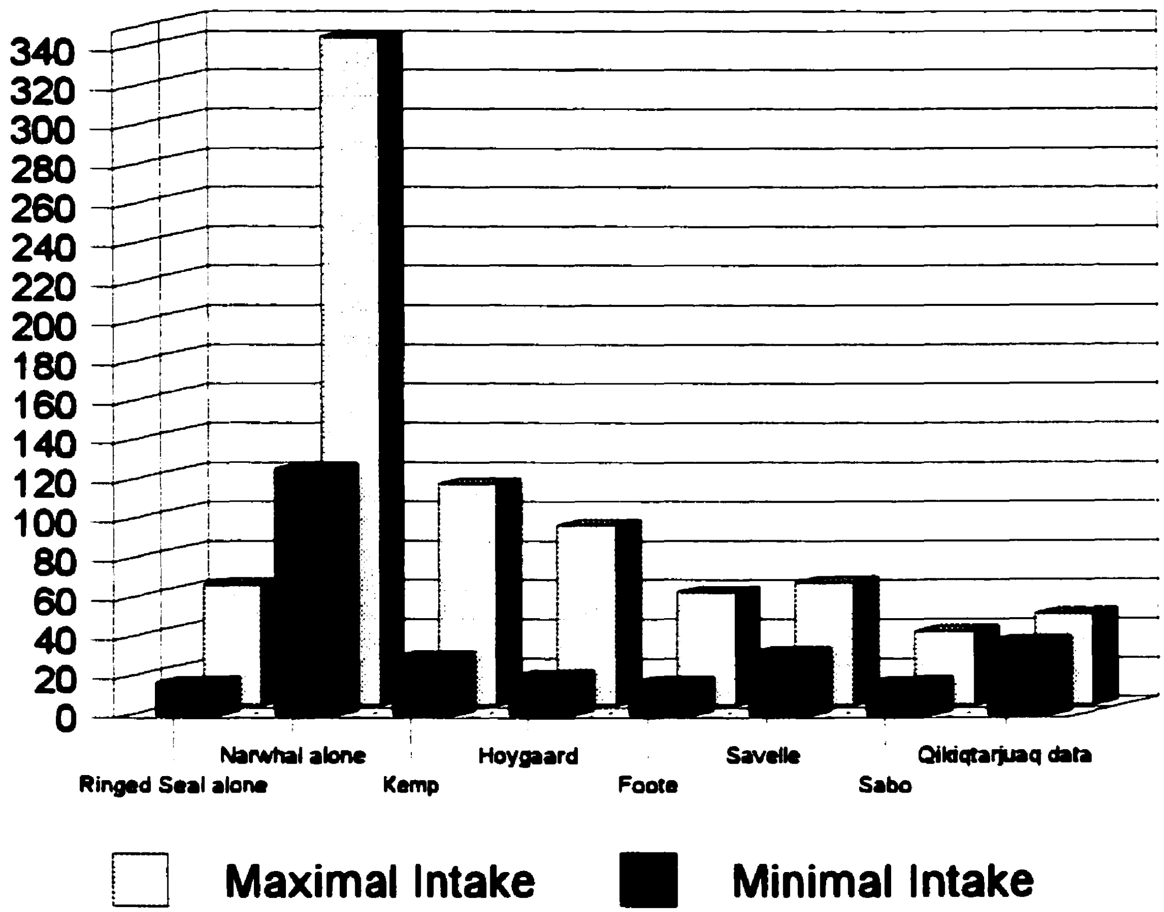
Conservatively, a diet containing 1100 g of meat or meat and organs would provide 17 - 62 mg of vitamin C per day. The breadth of range of vitamin C as calculated from the various data is between 17 mg - 113 mg of vitamin C on a diet primarily composed of animal sources with a minimal consumption of plants (< 2 % of energy).

Displayed in Figure 14.1 are the minimal and maximal average intakes of vitamin C calculated from the various sources of data on a diet containing 2500 calories. In the first two columns are a calculated range of intake of vitamin C for a diet containing either ringed seal or narwhal alone based on consumption of meat (minimal intake) or meat/organs (maximal intake) for ringed seal and meat/organs or mattak alone for narwhal. Both the minimal and maximal intakes reveal that adequate vitamin C levels were readily achieved through consumption of TF.

Given the rich sources of vitamin C available in the Inuit diet, intakes of vitamin C in at current recommended levels of 40 mg/day for adult men and 30 mg/day for women were obtainable based on the diet calculations outlined above. On occasions such as the feast after a successful whale hunt, intakes could easily approach upwards of 340 mg/day. On days when good animal sources and/or the quantity of food was limited, the additional use of plant sources such as kelp, commonly available at coastal sites, would have complemented the animal sources and easily boosted intakes to well above current recommended levels of vitamin C. Warmow, a Moravian missionary on Baffin Island in the fall of 1856 commented on the intake of the Inuit, who were trapped on a small island as the winter ice hadn't formed. Since no one could access the mainland to hunt or retrieve food caches "they have nothing to eat except occasionally a handful of seaweed which they dip in hot water and consume" (Ross 1997:111).

A limitation of these calculations is that they can only give a very generalized average intake and cannot account for seasonal and cyclic variation such as a shift in importance of a particular species to the contribution of vitamin C which might occur such as after a successful hunt of a bowhead whale. Bowhead whales which weigh between 10,000 kg (calf) and 50,000 kg could shift not only the balance of supply of food over a year and subsequent need for hunting but also the major source of vitamin C.

Figure 14.1 Comparison of Pre-Contact Intake of Vitamin C (mg/day)



Prior to commercial whaling, the bowhead was a major staple for many historic Inuit groups and their Thule ancestors. An average whale of 27,000 kg could yield 4600 kg of mattak, 4,600 kg of meat, 1,000 kg of organs and more than 10,000 kg of blubber, enough food and fuel to supply an average pre-contact camp of 25 people and 50 dogs (1400 kcal/dog) for over 8 months and a daily intake of vitamin C of more than 115 mg/person/day based on a diet of whale meat and mattak alone. For contemporary Inuit, as the population of bowhead appears to have recovered sufficiently, there is a strong interest to hunt this mammal again for cultural, social and food reasons (McGhee 1984, Savelle 1994, Hay 1997).

In Table 14.7 are examples of good seasonal sources of vitamin C. This seasonal summary is based on information from arctic ethnographers' descriptions of species harvested and collected over a calendar year (Section 2.2.5), the voices of Inuit such as Apphia Awa in Saqiyuq (quoted in Section 2.2.6), residents of Mittimatilik who consented to an interview (Section 15), and from Table 13.8. In each season, there were a few ready sources of vitamin C that consumed in small quantity would easily bolster the range of conservative calculations described above.

Table 14. 7 Examples of Good And Excellent Sources of Vitamin C Available Per Season

	Jan/ Feb	March /April	May/June	July/ August	Sept/Oct	Nov/Dec
Animal	Seal- liver Cached - whale mattak	Seal - liver Cached- whale mattak	Seal - liver Whale - organs ie. mattak, liver	Caribou - liver Char roe Whale, walrus - organs ie. liver, whale mattak	Caribou -liver Whale - organs ie. mattak, liver Walrus organs Char- roe	Seal-liver Cached - whale mattak
Plants			Roots, leaves, berries	Roots, leaves , berries	Roots, leaves, berries, kelp	Kelp

15. Inuit Perspectives on Health, Food and Vitamin C

Residents of Mittimatilik were interviewed for their perspectives on health, TF and MF and vitamin C. The people interviewed had lived in and around the community of Mittimatilik, spending part of their life in outpost camps and the nearby communities of Nanisivik, Arctic Bay and Clyde River where relatives lived. The interviews provided context for the current food choices and understanding of the meaning of vitamin C. Discussions with individuals allowed me to add enriching layers into the text which offers us insight on current influences and constraints on food choices and practices.

15.1 The Meanings of Health

I asked the question *'What does it mean to be healthy ?'* to various community members of Mittimatilik. People responded that there were many different ways to be healthy. Younger people stated that being healthy meant taking care of oneself, avoiding illness and preparation of the future. Actions that were linked to the concept of being healthy included not smoking, limiting one's consumption of coffee and tea, eating TF for its properties of strength, warmth and energy, eating MF that they considered healthy such as fruits and vegetables and limiting consumption of MF that were associated with 'sickness'. One young hunter described the symptom of sickness from MF as a feeling of tiredness if they were too frequently consumed. He associated chocolate, fruit cocktails, potato chips and soda with tiredness. The same hunter expressed that TF was always present in the family diet but he would feel 'tired of Inuk food' [bored] if it was the only food available. The lack of variety would be overcome through the purchase of MF, such as cheesecake, chocolate and soda pop during the early part of the month when money was available.

An elder approached this concept somewhat differently. She told me that words in Inuktitut that represented the concept of health were relatively new. She said that in the past, people were rarely sick and names for diseases were few. She told me about the meanings of three words which are 1) *aaiaqtuq*, meaning 'in pain'; 2) *qanimajuk*, which embodies the concept of being closer to death on the road of life, but not dying; 3) *inuusirluktuk*, which means life is not going very well. She described Baffin Island as 'paradise' a place where people have lots of game and where one could easily catch seals a short distance from the modern settlement from June until freeze-up. From her memories, she could only recall one day in her life when she had to go without food. A younger woman also expressed that living on Baffin Island was paradise but her frame of reference included the services available in the settlement. She perceived that life in the settlement was much easier than the nomadic lifestyle of her parents and grandparents.

15.2 Traditional Food Preferences

I asked people about their needs, preferences and reasons for use of TF. Most of the respondents stated that they ate TF a few times per week, if not on a daily basis, for reasons that included cultural identity, health, nutritional and economical benefits. In their words, TF was needed because 'it is in our blood', it 'stabilizes' and it keeps one 'full' and warm especially in winter, unlike MF. Additionally, people commented that they had learned through their parents and personal experience that TF provided them with more energy and strength and warded off illness. An older hunter who had spent considerable time in the south informed me that when he was younger he enjoyed MF but now in his later years he only ate TF as MF caused him considerable gastrointestinal distress.

Younger people described a preference for TF in season and/or which had not been frozen for longer than a few months, the exception being berries. According to respondents, food that had been frozen for too long (>2 months) tasted different, which might include the odour and taste of the packaging or freezer it had been stored. Older people expressed a preference for aged food such as walrus meat and narwhal mattak. However, according to one elder, the process of aging food is infrequently practised, making it difficult to acquire this type of food. In terms of species food preferences, young women and hunters reported infrequent consumption of parts other than the muscle portion of an animal, acknowledging that although their parents and elders consumed organs more frequently, they did not appreciate these parts. Young women stated that they might have ringed seal organs (kidney, intestines) once per year due to personal preference and/or availability. One hunter stated that use of the organs of animals such as seal was dictated in part by the difference in taste of the animal between winter and summer. In his family, organs were consumed more frequently (liver, kidney, intestines, brain) in the winter. In the summer, the seal would taste different or too strong and only the meat was eaten.

15.3 Changes in Traditional Food Use

I asked people to tell me about changes that had occurred in the use of TF in their lifetimes. Younger people (20 -30) generally did not believe that the quantity consumed had changed since their childhood but that the variety of TF tried had increased. Women (20 - 40) stated that their parents generally consumed a greater amount and variety of TF and were more likely to consume food raw, whereas they preferred boiled meat. One woman related that since losing a great deal of blood during childbirth, she had heeded the advice of friends and family members who recommended consumption of ringed seal meat to restore her strength. She told me that as a child although her mother had frequently told her to eat ringed seal meat, as it would keep her warm and give her strength, she avoided eating it. One elder mentioned that when she was younger, she enjoyed a greater variety of TF but younger people today eat only a few TF such as frozen caribou, boiled caribou and narwhal mattak. The variety of food she eats today is constrained by chewing difficulties and availability which is affected by current hunting practices and the preferences of others. One food that she recalled as no longer available was the traditional mixture of berries and fish eggs. Today, berries are only served on their own, as jam or with caribou fat. Another elder mentioned that when she was growing up there was a greater variety of TF available. She associated this change with overall availability of food. As a child, she remembered that the only parts of a seal that were not eaten were the urinary tract and gallbladder. Today, when she craves one of her favourite foods, ringed seal pup stomach, she purchases Philadelphia cream cheese instead. I asked this elder about the contribution of plant sources in her diet. She mentioned that treats included ptarmigan pouch and rabbit stomach for the children and caribou stomach for the adults.

Two women associated the decrease in use of TF with non-Inuit culture. One woman stated that as a child she seldom ate TF due in part to feelings of shame. She linked these feelings of shame to interactions with *Qadlunas* (white person [nurse]) whom she perceived to be disgusted by the Inuit traditional food system. As an adult, the attitudes of non-Inuit lost their strength over her and she increased her intake of TF. A younger woman remarked that as a child her mother always stopped eating and put away any country food if a *Qadluna* (white person) arrived in the house. As it was not a 'normal' practice to take this action, the young women put this practice down to feelings of shame.

Informants were asked about the roles of wild plants and how their use has changed in their diet as these may remain contemporary occasional summer sources of vitamin C and plants may have played a greater role in the diet. Plants were identified by name or from a fieldguide of arctic flora and fauna. Plants identified were *Empetrum nigrum* (blackberries), *Vaccinium uliginosum* (blueberries), *Epilobium latifolium* (broad-leaved willow-herb), *Oxyria digyna* (mountain sorrel), *Polygonum viviparum* (alpine bistort), *Saxifraga tricuspidata* (prickly saxifrage), *Salix spp.* (willow), *Rumex articus* (arctic dock) and a root called *airraq*. *Airraq* was recalled by all respondents as an annual food plant sought out as a treat. From the description of respondents, this plant appears to be *Pedicularis spp.* or an *Oxytrope spp.* although a positive identification could not be made from the field guide and drawings from other published work (Porsild 1953). The field guide proved very useful as a memory aid for plant identification. People often stated that there were other plants known that were not listed. In regard to the frequency of consumption of gathered plants, younger people mentioned that most of the plants were picked and usually eaten while walking. They might be used in a meal but most plants with the exception of berries were not collected in sufficient quantity for more than a day's use. Parents and elders collected and preserved berries over winter, either frozen or as jam. Other plants that might have been stored in the past over winter included seaweed and Arctic dock.

15.4 Knowledge of Vitamin C

Respondents were asked whether particular MF was purchased because of the presence of vitamins and/or if anyone took a vitamin supplement. Younger respondents were familiar with the term vitamin and on occasion would use this term to explain TF use ('bearded seal liver has too much vitamins so only a little might be eaten'), however food was associated generally with qualities of warmth, strength and taste but were not chosen because they were known to contain vitamin C. No one used or knew anyone who used a vitamin supplement although some young women remembered their mandatory daily use in school during the 1980's.

As I knew from analysis of recalls from Qikiqtarjuaq and observations while in the community of Mittimatilik that fruit-flavoured drinks in the form of crystal powder were frequently consumed, I asked people about decisions around fruit beverage selection at the store (frozen juice, canned juice, crystal powders). For younger people, cost was a determinant of product purchased, although four of the eleven women that I talked to stated that they preferred frozen juice when possible as they believed it to be more nutritious. No one read labels to determine if the product contained vitamin C. From a discussion with a nurse at the community health centre, I learned that frozen juice was promoted over the fruit-flavoured crystal powders because of the high sugar content in the latter. The nursing staff were unaware that particular brands of crystal powders were fortified with vitamins and that many of the frozen juice products contained low levels of vitamins.

15.5 Traditional Knowledge of Food as Medicine

Living on Baffin Island was described as a paradise by both young and old, a place where game was plenty and starvation was rare. Young people did not have in their memory stories of serious illness among the Inuit in the past. TF was perceived as an important aspect of being healthy and particular food was identified as having a medicinal role, such as the use of ringed seal blood for headaches, lemming skin as a bandage and particular plants as compresses. I had wondered prior to my journey to the north whether some Inuit, like the Danish living on the coast of Greenland, associated certain food with symptoms of scurvy. In this aspect I can only state that no one whom I interviewed remembered if a particular food had ever been used in the past to combat any of the symptoms I described as being associated with scurvy. I attribute this to an adequate varied diet that always contained adequate vitamin C as can be seen from the calculations in Section 14.

V. SUMMARY AND CONCLUSIONS

The traditional food system of the Inuit contains a variety of excellent sources of vitamin C. From the samples of food analysed for this project, levels of vitamin C above 30 mg/100 g were found in raw cisco eggs, raw beluga and narwhal mattak and mountain sorrel. Food which provided at least 20 mg/100 g of vitamin C included aged and boiled mattak, ringed seal and caribou liver, blueberries and kelp. Other organs and meat analysed provide 1-3 mg/100 g of vitamin C with the exception of ringed seal brain (14.80 ± 2.60 mg/100 g), caribou kidneys (8.88 ± 0.37 mg/100 g) and bearded seal intestines (6.12 ± 4.90 mg/100 g) which are fair sources of vitamin C. Other plants analysed for vitamin C (blackberries and cranberries) contained unexpected low levels when compared to the literature.

The variety and quantity of food available for analysis was limited by the time frame of the sample collection periods which took place during the seasons of Fall and Spring. The restrictions on sampling are speculated to have had a greater impact on the presence and absence of information about Arctic plants gathered in this thesis. While food plants may always have contributed little to the diet in terms of overall energy, they likely served as an important source of vitamin C and possibly other nutrients in the past and would therefore be of interest in terms of evaluation of the historical diet and as a possible current alternative source of vitamin C during their growing season. The laboratory results described in this thesis are a valuable addition to our knowledge of the vitamin C levels available in the traditional food system of the Inuit and serve as a further affirmation of the nutritional benefits of TF.

An analysis of Inuit vitamin C sources reveals adequate historic supply, in spite of the minor role of plants in the diet. Calculations of a pre-contact intake of vitamin C based on available data in the literature indicate that a minimal daily intake of vitamin C would have been between 17 - 113 mg/day on a diet containing 2500 kcal and a protein/fat/carbohydrate ratio of 45:49:6. Estimates calculated from a variety of sources provided similar conservative estimates of vitamin C, indicating that for my purposes that less variation in likely intake occurs when a greater variety of food is consumed. The low end of the range represents the calculation of vitamin C for a diet containing only meat. Based on the literature and interviews with community members of Mittimatilik about food choices, a usual intake of vitamin C would approach 100 mg given the usual historic practice of using the organs of animals as well as the reliance on stores of cached food in winter which often contained rich sources of vitamin C (narwhal, beluga). Additionally, from June until October, other sources of TF readily available and rich in vitamin C included caribou liver, fish eggs and plants which were picked and eaten while walking. From the standpoint of nutrition, in 1974 the Nutrition Survey of Canada concluded that the Inuit were at risk of vitamin C deficiency. The result was fortification of food. At issue was the real change in intake of TF due to the shift from camp to a settlement lifestyle with the negative repercussions on cultural practices.

Analysis of the dietary intake of women aged 20 - 40 in Qikiqtarjuaq (1987-1988) revealed that the median intake of vitamin C was often below the 1990 RNI of vitamin C. and below the 2000 DRI. Interviews were recently conducted in Qikiqtarjuaq as part of a larger survey conducted in 18 communities. The median intake of vitamin C (n=23) was 24 mg/day and only 35% of the group had intakes above the EAR, indicating that women in this age group do not appear to be regularly obtaining an adequate intake of vitamin C.

A limited number of TF and MF consumed daily form the primary sources of vitamin C among women in the community of Qikiqtarjuaq. The decrease in TF use may be attributed to factors of personal preference, cultural norms, cost, availability, change in lifestyle and acculturation. As in the words of two Baffin Island residents,

> "Today when a whale is caught, it is cut wherever it is convenient regardless of its possible uses. Very small parts of the meat or intestines are taken, and the parts that were eaten as a delicacy are hardly touched"(Jooeelee Papatsie, hunter in Kilabuk 1998)

> "My grandmother used all parts of the caribou, even to the bones. We no longer boil the bones, we waste lots of the caribou as not all parts are eaten" (Mittimatilik women, personal communication 1999)

Fresh TF is available in the community during the summer which is well liked and rich in vitamin C. Although fresh seal and caribou may be accessible for some community members for most of the year, younger women in Qikiqtarjuaq infrequently consumed portions other than muscle meat. Although TF was recalled by the majority of women in Qikiqtarjuaq in each season, the sources frequently mentioned in the 24 hour recalls were primarily ringed seal and caribou meat which contain between 1 - 2 mg/100 g of vitamin C. Due to the infrequent consumption of rich sources of TF, the mean intake of vitamin C from TF was below 10 mg during five seasons. In early fall, the intake of vitamin C from TF was significantly higher with a mean intake of 24 ± 6 mg (mean ± SE) due to a more frequent consumption of rich sources of vitamin C that were harvested during this period. For the few women who mentioned inclusion of rich sources of vitamin C in their diet (mattak, ringed seal liver, kelp, berries) the amounts consumed provided an intake of vitamin C intake at levels approaching 200 mg per day. If parts other than meat were consumed, the quantity generally remained below 100 g with the exception of narwhal mattak.

Rich food sources of vitamin C such as narwhal mattak may be available throughout the year at the community freezer in limited to sufficient quantity, but are infrequently consumed out of season by this group. From qualitative interviews at Mittimatilik, young people enjoyed the taste of fresh mattak and claimed that their personal stores usually ran out by November. In the case of Mittimatilik, the freezers at the Hunters and Trappers' Organization and at the MF store had narwhal mattak available from the previous summer available in the spring of 1999. Sales were infrequent. The store manager at the Northern in Mittimatilik informed me that he was considering discontinuing the practice of carrying TF for sale as people did not buy it. Reasons that the young people gave for not purchasing TF included taste (lack of freshness, mattak absorbed the plastic odour of the packaging), cost and the cultural belief that TF was obtained through hunting and sharing with family, not through its purchase. The young hunters that I talked to informed me that if they wanted TF they would obtain it through family if they could not hunt themselves rather than buy it. In the spring of 1999, hunters were taking arctic char through the ice in nets, ringed seal, ptarmigan and arctic hare (elder requests), and some caribou for a community feast, personal use and dog food.

For the majority of the group of women interviewed in Qikiqtarjuaq, only a few fortified foods available in the community provided the bulk of the vitamin in each season. Over the calendar year the primary sources of vitamin C were a few fortified foods (fortified fruit flavoured beverage, evaporated milk, apple juice, potato chips).

Erosion of reliance on the traditional food system and an increased consumption of imported MF, often of inferior quality, has resulted in an increased risk of nutrient inadequacy for this population (Sabry *et al.* 1974, Verdier *et al.* 1987, Kuhnlein *et al.* 1995, Kuhnlein *et al.* 1996, Kuhnlein & Receveur 1996). Re-invigorating TF in Inuit diets has cultural, economic and nutritional benefits and is recommended here.

Vitamin C intake among this population in the past appears to have been ample. However, current intakes of vitamin C tend to be marginal with MF providing the larger portion of energy and vitamin C in the diet. In light of the proposed RDA of 75 mg/day and the low intake of vitamin C reported here as well as the reported high rate of smoking among Inuit (Lawn *et al.* 1998), nutrition education should focus on the promotion of excellent traditional food sources and market food vitamin C sources, with an emphasis on fortified food sources which are acceptable in taste and cost.

Nutrition education needs to involve incorporation of elders' knowledge about the values of using a variety of parts of an animal rather than the meat alone. Nutrition education can point out the 'nutritional benefits' of particular food items. However their consumption is determined by taste preference, cultural beliefs, accessibility and usual practices. Young people tend to consume only the muscle portion of an animal. In my interviews only the elders spoke with relish of the organs of animals and they expressed dismay about the infrequent use of the variety of parts from an animal by younger people. One woman told me that she lost a lot of blood giving birth to one of her children. As a child she had been frequently told by her mother to eat ringed seal meat raw but had refused, growing up on caribou meat. After this traumatic event she listened to the words of her family and friends who repeated that the raw ringed seal meat would give her strength. Now she frequently consumes ringed seal meat raw a few times a week. Other women told me that as they grew older the quantity of TF increased but their choices rarely included parts other than muscle and whale mattak of whales. Exceptions occurred during long stays in camp, identified as a setting in which one would get used to the stronger flavoured parts, or if one had parents or relatives who would prepare and offer organs such as the stomach and intestines.

In the south, there are many other readily available and economically affordable sources of nutrients such as vitamin C. In the isolated northern Inuit communities, the usual fruit and vegetable sources of vitamin C and other nutrients are extremely costly and often the products available are limited in variety and/or not of appropriate quality.

With respect to the use of MF, crystal fruit flavoured beverages are a common household item whereas frozen juice was recalled infrequently by this age group. The use of fortified and non-fortified crystals and frozen juice may reflect issues of cost, education and personal taste preferences. Fortified fruit beverage powder was recalled by 22 women. Non-fortified juice crystals were recalled by 36 women. Alternatively, 19 women used both fortified and non-fortified juice crystal powder. Fortified beverage crystals are usually more costly than non-fortified crystals in the food stores in the Arctic.

In Canada, regulation around fortification of products differs from the USA. For instance, Koolaid, a product available in the community is commonly fortified in the USA but not in Canada. On the consumer side of this picture, cost rather than marketing may be a stronger determinant of a product's use. Due to the limited number of good market sources that are utilized by this group, it would be valuable to talk with the regional nutritionists, government nutritionists, community members and store managers around this issue. As juice crystals were a commonly used item by 83 % of the women interviewed, decreasing cost difference between fortified and non-fortified juice crystals might be a simple method to increase vitamin C intake among Inuit women and other age groups. Preliminary data analysis from a recent survey "Assessment of Dietary Benefit: Risk in Inuit Communities" (CINE, McGill University) that included interviews of women aged 20 - 40 (n=26) conducted in the community of Qikiqtarjuaq during Fall 1998 and Winter

1999 indicate that this group did not mention the use of fortified juice crystals. The primary fruit beverage drinks chosen were non-fortified juice crystals (Koolaid) with 10 mentions of use and two mentions of frozen orange juice. Other options to encourage a higher intake of vitamin C include changes to the current fortification regulations to ensure that a greater variety of products have added vitamin C and the promotion of good sources of vitamin C.

When I asked people in Mittimatilik about reasons for purchasing a particular juice crystal powder in the market, cost was a determining factor. Nutrition was not a consideration in food choice purchase of a specific crystal powder. Some women stated that they purchased frozen juice because they believed it to be 'better' or more nutritious but their comments revealed that no particular brand was purchased for the presence of vitamins. During the time that I was in Mittimatilik it was Nutrition Month. The nursing station had a display about healthy eating at the Northern Store. As part of their nutrition education they were promoting abstinence from caffeine if pregnant and avoidance of fruit flavoured crystal powder drinks. The nurse in charge of this event, told me that they were promoting blanket use of frozen juice rather than fruit flavoured crystal drinks because of the lower sugar content. She was not aware of any differences between brands (frozen or fruit flavoured crystal drinks) with respect to valuable nutrients such as vitamin C or due to cost differences. However, it is encouraging to see nutrition being promoted in communities and these messages seem to have an impact among some residents.

Through the education system children are exposed to a wide range of subjects. One of these includes education about similarities and differences between cultures. Food remains at the centre of many cultures, wrapped within issues of identity. When non-Inuit learn about Inuit culture, images of igloos, fur, ice and seals are presented. For the southerner, Inuit represent a culture steadfastly surviving in a difficult climate. A common wonder for these outsiders is how Arctic people obtained adequate vitamin C. Clearly for the Inuit, this mystery was not a relevant question, yet for the younger generations the transition from TF to MF has resulted in a frequent replacement of nutrient dense sources of TF with poorer sources and a probable decrease in vitamin C intakes.

Beyond the applications of the results of this thesis for future evaluation of diets containing these uncultivated foods and for purposes of nutrition education with respect to the nutritional benefits of Inuit TF, the results from this thesis also have an application in the mainstream education system. Currently children across Canada learn about the Inuit in the classroom but there is a lack of information as to the nutritional aspects of the Inuit diet with respect to current and historical practices. The vitamin C results from this thesis could provide a useful component in the instruction of young people about the unique traditional food system of the Inuit and as a wonderful method by which to teach children about the appropriateness of different diets for different climates, local food use, variety of food.

As a final word, the limitations of this thesis which set out to determine the sources of vitamin C in the Inuit diet and the contemporary and historical intakes of vitamin C in this population need to be mentioned. With respect to the vitamin C sources, the TF analysed were limited to a sample size often less than three. Ideally a sample size approaching 10 would better account for the variation in food. Additionally the TF collected were limited to what food was available during two collection periods. Constraints precluded the collection of possible plants eaten and larger sample sizes of food that may be limited in communities. Changes in TF use and type of data available re: historical food use allow us only to generalize about the intake of vitamin C in the past. There may be several other potential food items, not analysed here due to infrequent modern use and issues of non-availability, which may have been an important source of vitamin C in the past. Finally, the available data analysed for the contemporary intake of vitamin C was limited to women from one community on Baffin Island, which can only stand as a suggestion for intake among this age group of Inuit women but cannot be applied specifically to other communities.

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APPENDICES

Appendix A. Traditional Food Intake in Qikiqtarjuaq Ranked by Fresh Weight										
Food	***Part***	***Prep.***	***Frequency***	***Fresh weight kg***	***Percentage of total weight of traditional***	***Percentage of total weight including market foods***	***Frequency of Mention in Household***	***Rank***	***Frequency of Use Females***	***Rank***
R. seal	meat	boiled	306	13295	18.5	2.75			232	1
Caribou	meat	raw	179	11610	16.25	2.25	532	2	109	5
Caribou	meat	boiled	193	8115	11.25	1.75			138	2
R. seal	meat	raw	126	6265	8.75	1.25	573	1	89	7
Narwhal	mattak	raw	124	5050	7	1	319	5	85	8
R. seal	broth	boiled	115	4655	6.5	1			91	6
Arctic char	meat	boiled	60	2640	3.75	0.5	1	59	46	12
Walrus	meat	aged	27	2205	3	0.5	67	29	21	18
Kelp		raw	25	2055	2.75	0.5	172	10	28	14
R. seal pup	meat	boiled	11	1500	2	0.25			7	34
Narwhal	meat	dried	9	1205	1.75	0.25	144	15	25	15
Mussels		raw	5	1100	1.5	0.25	130	20	3	45
Blackberries		raw	61	1085	1.5	0.25	160	11	121	3
R. seal	blubber	boiled	137	1025	1.5	0.25			110	4
Arctic char	meat	raw	53	1000	1.5	0.25	496	3	44	13
Walrus	blubber	aged	28	830	1.25	0.25			22	17
Caribou	meat	dried	17	745	1	0.25			13	21
R. seal	blubber	raw	71	700	1	0.25			48	10
Narwhal	mattak	boiled	13	685	1	0.25			9	25
R. seal	meat	aged	6	625	0.75	0.25			9	26
R. seal pup	meat	raw	6	500	0.75	0			6	38
Walrus	meat	raw	4	500	0.75	0	139	16	3	43
Caribou	fat	raw	94	476	0.75	0			73	9
B. seal	meat	dried	9	455	0.75	0			7	33
Walrus	mattak	aged	4	405	0.5	0	39	36	4	42
R. seal	liver	raw	14	400	0.5	0	308	7	15	19
R. seal	flippers	aged	5	375	0.5	0	16	42	7	30
Blueberries		raw	11	320	0.5	0	145	13	23	16
Narwhal	blubber	raw	67	320	0.5	0			48	11
Caribou	marrow	raw	15	305	0.5	0			12	22
B. seal	meat	boiled	14	250	0.25	0			8	29
Arctic char	meat	dried	11	225	0.25	0			6	37
R. seal	blubber	aged	6	198	0.25	0				
Sculpin	meat	raw	3	155	0.25	0	22	41	8	28
R. seal pup	blubber	boiled	10	128	0.25	0			6	39
R. seal	heart	raw	8	125	0.25	0	147	12	7	31
R. seal	brain	raw	4	80	0	0	103	24	3	46
Clams	contents	raw	7	72	0	0	137	18	3	48
B. seal	blubber	boiled	10	63	0	0				
Caribou	heart	raw	3	60	0	0			3	49
Narwhal	blubber	boiled	10	60	0	0				
Arctic char	skin	raw	14	51	0	0	422	5	9	2

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

			THESIS RESULTS							Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
Cranberries	*Vaccinium vitis idaea*	berry	raw	2	84.35	1.34	2	3.87	1.30	2	84.48-86.7				5	17-108						
												4	84.48	1.81			3	21.1	6.2	Brown, 1954	Roe & Kuether, 2,4 dinitrophenylhydrazine	collected in Jan-April, possible interference from sugars
													n/a				2	108		Rodahl, 1952	Tillman's, 2,6-dichloroindophenol	
												1	86.7				1	21		Heller & Scott, 1961	Roe & Kuether, 2,4-dinitrophenylhydrazine	raw, edible portion no info on storage
													n/a				1	17		Hjarde, 1952	Tillman's, 2,6-dichloroindophenol	metals interfere (only measures AA)
													n/a				1	22.5		Hoffman, Nowosad, Cody 1967	Pepkowitz, 2,6-dichloroindophenol	
Blueberries	*Vaccinium uliginosum*	berry	raw	3	85.41	1.33	3	26.20	4.90							n/a						
Blackberries	*Empetrum nigrum*	berry	raw	5	87.95	1.11	5	2.41	0.80	3	87.75-89				4	9-51						
												2	89	2.9			1	16.4		Kuhnlein & Soueida, 1992	Pelletier & Brassard, 1977 Automated DNPH	Stored whole @-20 C for 1 year
												1	89.2				1	9		Hoygaard, 1941	Emmerie 2,6-dichloroindophenol	Looked at food stored in winter bags No vit c in dried berries
																	2	30	6	Hoffman, Nowosad and Cody, 1967	Pepkowitz, 2,6-dichloroindophenol	
												4	87.75	2.61			3	51.1	6.7	Brown, 1954	Roe & Kuether, 2,4-dinitrophenylhydrazine	collected Jan-April sugars may interfere
Baked appleberry	*Rubus chamaemorus L.*														1		1	47.5		Hoffman, Nowosad Cody, 1967	Pepkowitz, 2,6-dichloroindophenol	
Mountain Sorrel	*Oxyria digyna*	leaves and stem	raw	1	86.89		1	41.57							4	93-95						
		leaves											n/a					40		Berkes & Farkas, 1978	Unknown	Unpublished data from 1974 report

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

			THESIS RESULTS							Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
Mountain Sorrel		leaves and stem	fresh										n/a					40		Hoffman, Nowosad Cody, 1967	Pepkowitz, 2,6 dichloro indophenol	Collection no refers to voucher specimen no
																	1	9 3		Hoygaard, 1941	Emmene 2,6 dichloroindophenol	
													n/a					95		Rodahl, 1952	Tillman's, 2,6 dichloroindophenol	
Kelp	*Alaria spp*	plant								2	73 9 84 8				3	55-69						
																	2	5 5	n/a	Rodahl, 1952	Tillman's, 2,6 dichloroindophenol	
Kelp	*Alaria spp*	plant										1	73 9					69		Mann et al 1962	2,4 dinitrophenylhydrazine	info lacking re storage, etc
												1	84 8				2	45	0 5	Hoygaard, 1941	Emmene 2,6 dichloroindophenol	
Kelp	*Fucus spp*	plant	raw	1	72 49	0 16		4 37		1	84 6				2	9 13						
																	1	9		Rodahl, 1952	Tillman's, 2,6 dichloroindophenol	
												1	84 6				2	13	1 5	Hoygaard, 1941	Emmene 2,6 dichloroindophenol	
Kelp	*Laminaria spp*	plant	raw	1	73 85	0 22		28 36		2	81 84 2	1			1	50						Only 1 reference for published
												2	81							Kuhnlein & Soueida, 1992		
												1	84 2				1	50		Mann et al 1962	Roe & Kuether, 2,4 dinitrophenylhydrazine	info lacking re storage, etc
Kelp	*Rhodymenia palmata*	leaves						n/a		1	84				2	10 17						
												1	84				2	17	4	Hoygaard, 1941	Emmene 2,6 dichloroindophenol	
																		10		Hoffman, Nowosad and Cody, 1967	Pepkowitz, 2,6 dichloroindophenol	
Willow	*Salix arctica*	leaves						n/a					n/a		4	160 430						
													n/a					190		Berkes & Farkas	Unknown	Unpublished data from 1974 report

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

THESIS RESULTS										**Published Data**												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
Willow	*Salix planifolia*	leaves						n/a					n/a				3	430	30	Hoffman, Nowosad and Cody, 1967	Pepkowitz, 2,6-dichloroindophenol	Collection no. refers to voucher specimen no.
													n/a				3	192.5		Rodhahl, 1952	Tillman's, 2,6-dichloroindophenol	
																	2	160	70	Rodhahl, 1952	Tillman's, 2,6-dichloroindophenol	
	Salix reticulata							n/a		1		1	67					n/a		Kuhnlein & Soueida, 1992		
Eskimo potato	*Hedysarum alpinum*	roots											67.8					11		Heller and Scott, 1961	Roe & Kuether, dinitrophenylhydrazine	
Fireweed	*Epilobium latifolium*	young leaves						n/a		1			87.2		2	99 152						
																	1	99		Heller and Scott, 1961	Roe & Kuther dinitrophenylhydrazine	
																	1	152		Hoffman, Nowosad, Cody, 1967	Pepkowitz, 2,6 dichloroindophenol	
Fireweed	*Epilobium latifolium*							n/a									2	132		Rodhahl, 1952	Tillman's, 2,6 dichloroindophenol	
Bistort	*Polygonum spp*	roots						n/a		1			77.2		1		1	16		Heller and Scott,1961	Roe & Kuther dinitrophenylhydrazine	
Bistort	*Polygonum viviparum*	leaves													1		1	158.8		Hoffman, Nowosad & Cody, 1967	Pepkowitz, 2,6 dichloroindophenol	
Prickly saxifrage	*Saxifraga tricuspidata Rottb*	Flower & stem						n/a							1		1	135.5		Hoffman, Nowosad, Cody, 1967	Pepkowitz, 2,6 dichloroindophenol	
R. Seal	*Phoca hispida*	liver	raw	3	72.35	0.39	3	23.80	3.82	2	70.8 71				4	7 35						
												2	71							Kuhnlein & Soueida, 1992		
																		20		Helms, 1985	unknown	
													70.8					7		Farmer, 1971	dichloroindophenol	analysis on freeze dried samples

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

				THESIS RESULTS						Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
R. Seal	*Phoca hispida*	liver	raw										n/a					35		Geraci & Smith 1979	Roe & Kuether, 2,4 - dinitrophenylhydrazine	
																	4	11 9	2 2 6	Rodahl, 1949	Tillman's, 2,6 dichloroindophenol	•
		meat	raw	3	70 33	1 64	3	1 55	0 50	3	67.73				6	52 4						
												2	73							Kuhnlein & Soueida, 1992		
																		4		Mann et al 1962	Roe & Kuether, 2,4 - dinitrophenylhydrazine	
													68					3		Farmer, 1971	Tillman's, 2,6 dichloroindophenol	analysis on freeze dried samples
																		0 52		Hjarde, 1952	Tillman's, 2,6 dichloroindophenol	metals interfere only measures reduced aa
																	2	0 7	0 2	Rodahl, 1949	Tillman or Emmene 2,6 dichloroindophenol	
													n/a				1	3		Geraci & Smith 1979	Roe & Kuether, 2,4 - dinitrophenylhydrazine	
												2	67 45	2 2			2	0 52	0 1	Hoppner et al, 1978	Pelletier & Brassard, dinitrophenylhydrazine	-20C until analysis no date no duplicate
		meat	boiled	1	64 92		1	1 19		2	63 65 9				1		1	0 47				
												2	63							Kuhnlein & Soueida, 1992		
												1	65 9				1	0 47		Hoppner et al 1978	Pelletier & Brassard, dinitrophenylhydrazine	-20C until analysis no date, no duplicate
		meat	aged					n/a		1	68							n/a				
												2	68							Kuhnlein & Soueida, 1992		
		Flippers	aged					n/a		1		1	61					n/a		Kuhnlein & Soueida, 1992		
(Fjord Seal)		Flippers	aged									1	57 8					0 9		Hoygaard, 1941	Emmene 2,6 dichloroindophenol	
R. Seal	*Phoca hispida*	brain	raw	4	77 55	0 1	4	14 86	2 60	1	75							n/a				
												2	75	0 6						Kuhnlein & Soueida, 1992		

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				THESIS RESULTS						Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
R. Seal	*Phoca hispida*	eye (pooled)	raw	3	85.69	1.85	3	3.27	0.68	1	85							n/a				
												2	85	0.2						Kuhnlein & Soueida, 1992		
		heart	raw					n/a		2	74 76							n/a				
												1	74							Rodahl, 1954	Emmerie 2,6-dichloroindophenol	
												2	76	2.2						Kuhnlein & Soueida, 1992		
R. Seal pup		meat	raw					n/a		1		1	75					n/a		Kuhnlein & Soueida, 1992		
		meat	cooked					n/a		2	60 60.6							n/a				
												1	60.6				1	0.66		Hoppner, 1978	Pelletier & Brassard, dinitrophenylhydrazine	20C until analysis no dates, no duplicates
												1	60							Kuhnlein & Soueida, 1992		
		liver	cooked					n/a		1		1	70.1				1	30.49		Hoppner, 1978	Pelletier & Brassard, dinitrophenylhydrazine	20C until analysis no dates, no duplicate
B. Seal	*Erignathus barbatus*	intestines	raw					n/a		1	17				2	0 1						
												1	17							Kuhnlein & Soueida, 1992		
																		0		Helms, 1985	unknown	
																		1		Geraci & Smith 1979		
		intestines	boiled	2	74.64	0.64	2	6.12	4.90	1	73				1	0.9						
												1	73							Kuhnlein & Soueida, 1992		
																	1	0.9		Geraci & Smith 1979		
		meat	raw					n/a					n/a		4	0.5 25						
																		25		Mann et al 1962	Roe & Kuether, 2,4 dinitrophenylhydrazine	

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

Food	Latin Name	Part	Prep	THESIS RESULTS n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	Published Data # References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
B Seal	*Erignathus barbatus*	meat	raw															0 5		Hjarde, 1952	Tillman's, 2,6-dichloroindophenol	metals interfere Only measures reduced aa
								n/a					n/a				1	1		Geraci & Smith 1979	Roe & Kuether, 2,4-dinitrophenylhydrazine	
																	2	0 5		Rodahl, 1949	Tillman's, 2,6-dichloroindophenol	
		meat	dried					n/a		1	73											
												2	73	0 4						Kuhnlein & Soueida, 1992		
		meat	boiled	2	62 68	0 64	2	0 95	0 50	1	64											
												2	64	1 1						Kuhnlein & Soueida, 1992		
Beluga	*Delphinapterus leucas*	mattak	raw	6	68 43	2 72	6	36 02	8 73	3	50 5 68				4	2 25						
												1	68							Kuhnlein & Soueida, 1992		
												1	50 5					25		Helms, 1985	unknown	Value from Hjarde? As seems to be Greenland food table
																		2		Mann et al 1962	Roe & Kuether, 2,4-dinitrophenylhydrazine	
													n/a					25		Geraci & Smith 1979	Roe & Kuether, 2,4-dinitrophenylhydrazine	no moisture, not sure of area used
												1	50 7				1	25		Hjarde, 1952	Tillman's, 2,6 dichloroindophenol	Must include layer of blubber
		mattak	boiled	2	60 61	13 07	2	23 63	4 66				n/a					n/a				
		meat	raw					n/a		2	68 71 3				3	5 3						
												1	71 3					3		Farmer, 1971	Tillman's, 2,6-dichloroindophenol	analysis on freeze-dried samples Suspect inaccurate
																		0 5		Geraci & Smith 1979	Roe & Kuether, 2,4-dinitrophenylhydrazine	
												1	68				1	<1		Hjarde, 1952	Tillman's, 2,6-dichloroindophenol	metal interferes only measures reduced aa

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

			THESIS RESULTS							Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
Beluga	*Delphinapterus leucas*	meat	dried	1	42 03		1	1 14		1	48 7				1	<1						
												1	48 7					<1		Hjarde, 1952	Tillman's, 2,6-dichloroindophenol	metal interferes only measures reduced aa
Narwhal	Monodon monoceros	mattak	raw	6	71 71	1 88	6	31 51	6 96	4	57 1 72				4	20 32						only 3 references have both moisture and vitamin c
												2	72	0 9						Kuhnlein & Soueida, 1992		
			raw									1	60 4				1	30		Helms, 1985	unknown	suspect taken from Hjarde's published data
												1	70 2				2	20	2 9 5	Hoygaard, 1941	Emmene 2,6 dichloroindophenol	
Narwhal	*Monodon monoceros*	mattak	raw									1	57 6				1	31		Hjarde, 1952	Tillman's, 2,6 dichloroindophenol	metal interferes only measures reduced aa
													n/a				2	31 75	2 2 5	Rodahl, 1949	Tillman's, 2,6 dichloroindophenol	
		mattak	boiled					n/a		1	74											
												2	74	0 2						Kuhnlein & Soueida, 1992		
		mattak	aged	1	62 31		2	20 68	4 15	1	69				1		1	0 6				
												1	69							Kuhnlein & Soueida, 1992		
													n/a					0 6		Hoygaard, 1941	Emmene 2,6 dichloroindophenol	food stored in blubber bag so aged
		meat	raw					n/a		3	65 76				2	0 5 1 2						
												1	65				1	0 5		Hjarde, 1952	Tillman's, 2,6-dichloroindophenol	metal interferes only measures reduced aa
												1	76 2				1	1 2		Hoygaard, 1941	Emmene 2,6-dichloroindophenol	
												1	67 3					1		Helms, 1985	unknown	
																		3		Mann et al 1962	Roe & Kuether, 2,4 dinitrophenylhydrazine	
		meat	dried					n/a		3	17 25				2	0 2						
												2	21 6	0 01			2	2		Hjarde, 1952	Tillman's, 2,6-dichloroindophenol	metal interferes only measures reduced aa0

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

				THESIS RESULTS						Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
Narwhal	*Monodon monoceros*	meat	dried									2	17							Kuhnlein & Soueida, 1992		
												1	25				1	0		Helms, 1985	unknown	
Walrus	*Odobenus rosmarus*	meat	raw	1	73 10			1 00		3	70 5 74	2			2	1 3						
												1	71 4				1	1		Hjarde, 1952	Tillman's 2,6-dichloroindophenol	
												1	70 5				1	3		Farmer, 1971	Tillman's 2,6-dichloroindophenol	
												2	74							Kuhnlein & Soueida, 1992		
		meat	aged	1	64 05			0 85		1	69											
												2	69	1 5						Kuhnlein & Soueida, 1992		
Walrus	*Odobenus rosmarus*	muktuk	aged					n/a		1	62											
												2	62							Kuhnlein & Soueida, 1992		
		muktuk	raw	1	64 40			0 70		1	64											
												2	64	1 4						Kuhnlein & Soueida, 1992		
Caribou	*Rangifer tarandus*	meat	raw	1	71 04			0 86		2	74				4	0 76 3						
																				Helms, 1985	unknown	
																		3		Mann et al, 1962	Roe & Kuether, 2,4-dinitrophenylhydrazine	no idea re sample
												1	74 8				1	3		Farmer, 1971	Tillman's, 2,6 dichloroindophenol	
												1	74				1	0 76		Hoppner et al 1978	Pelletier & Brassard, dinitrophenylhydrazine	20C until analysis no dates, no duplicate
																	1	1		Geraci & Smith 1979	Roe & Kuether, 2,4-dinitrophenylhydrazine	
		meat	roasted					n/a		1	60 8				1	0 43						
												1	60 8				1	0 43		Hoppner et al 1978	Pelletier & Brassard, dinitrophenylhydrazine	20C until analysis no dates, no duplicates

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

			THESIS RESULTS							Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
Caribou	*Rangifer tarandus*	heart	raw	3	76.59	1.86	3	2.36	0.41	1	76							n/a				
												1	76							Kuhnlein & Soueida, 1992		
		liver	raw	4	71.49	3.16	4	23.76	4.92				n/a					n/a				
		stomach	walls	6	78.61	3.38	6	0.45	0.39	1	78							n/a				
												1	78							Kuhnlein & Soueida, 1992		
		stomach	contents	3	78.86	1.38	3	1.01	1.02	1	77							n/a				
												1	77							Kuhnlein & Soueida, 1992		
		kidney	raw	2	74.80	4.43	2	8.88	0.37				n/a					n/a				
		kidney	boiled	2	65.01	3	2	7.24	3.14				n/a					n/a				
Arctic Char	*Salvelinus alpinus*	whole	raw					n/a							1	5.8						
																	1	5.8		Geraci & Smith 1979	Roe & Kuether, 2,4 dinitrophenylhydrazine	
		flesh	raw	2	80.96	1.48	2	1.23	0	2	68.2 76											
												1	76							Kuhnlein & Soueida, 1992		
												1	68.2				1	0.48		Hoppner et al 1978	Pelletier & Brassard, dinitrophenylhydrazine	20C until analysis no dates, no duplicates
Arctic char	*Salvelinus alpinus*	flesh	dried					n/a														
																	1	1.8		Geraci & Smith 1979	Roe & Kuether, 2,4 dinitrophenylhydrazine	
Sculpin	*Myoxocephalus spp.*	flesh	raw	1	79.47		1	1.05		1	78											
												1	78							Kuhnlein & Soueida, 1992		whole sculpin

Appendix B - Vitamin C Values for Traditional Food - Thesis Results and Published Values

			THESIS RESULTS							Published Data												
Food	Latin Name	Part	Prep	n	Moisture g/100 g	SD	n	Vitamin C mg/100g	SD	# References	Range	n	Moisture g/100 g	SD	# References	Range	n	Vitamin C mg/100 g	SD	Reference	Method	Notes
Mussels	*Mytilus edulis*	meat	raw					n/a		2	89.7				1	<1						
												1	89.7				1	<1		Hjarde, 1952	dichloroindophenol	•
Clams	*Mya spp.*	meat	raw	2	77.63	0.64	2	3.69	3.1	2	74 81.8											
												1	74							Kuhnlein & Soueida, 1992		
												99	81.82							USDA 1987		
B. Whitefish	*Coregonus nasus*	flesh	raw	3	73.53	5.46	3	2.83	1.11	1	80							n/a				
												1	80							Kuhnlein & Soueida 1992		
		flesh	boiled	2	69.63	1.39	2	2.15	0.16	1	74											
												1	74							Kuhnlein & Soueida, 1992		
Cisco	*Coregonus autumnalis*	roe		2	62.56	3.98	·2	49.6	12.3	1	73.7				1	7						
												1	73.7				1	7		Mann et al 1962	Roe & Kuether, 2,4 - dinitrophenylhydrazine	
Ptarmigan	*Lagopus mutus*	meat	raw	1	73.49		1	1.7		1	72.9				3	1.2 7						
												1	72.9				1	<2		Hjarde, 1952	Tillman's method, 2,6 dichloroindophenol	no details
																	1	7		Mann et al 1962	Roe & Kuether, 2,4 - dinitrophenylhydrazine	
																	1	1.2		Geraci & Smith 1979		
		whole	boiled	1	62.38		1	2.89					n/a									
Snow Hare	*Lepus timidus*	stomach	raw					n/a					n/a		1	10.6						
													n/a				2	10.6	28.5	Rodahl 1949	Tillman's method, 2,6-dichloroindophenol	

Appendix C. Sample Profile							
Food category	**Common Name**	**Part**	**Prepared State**	**Code**	**Community**	**Harvest Date**	**CINE Lab Arrival**
Fish & Shellfish	Arctic char	flesh	raw	IN107	Rigolet	Oct. 1998	Dec 1998
	Arctic char	flesh	raw	IN49	Baker Lake	Oct. 1998	Dec 1998
	Sculpin	flesh	raw	IN18	Qikiqtarjuaq	Sept. 1998	Dec 1998
	B. Whitefish	flesh	raw	IN41-1	Paulatuk	Sept. 1998	Dec 1998
	B. Whitefish	flesh	raw	IN41-2	Paulatuk	Sept. 1998	Dec 1998
	B. Whitefish	flesh	raw	IN50	Baker Lake	Oct. 1998	Dec 1998
	Cisco	roe	raw	IN31	Tuktoyaktuk	Oct. 1998	Dec 1998
	Cisco	roe	raw	IN40	Tuktoyaktuk	Sept. 1998	Dec 1998
	Clams	flesh	raw	IN9	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Clams	flesh	raw	IN2	Qikiqtarjuaq	Sept. 1998	Dec 1998
Plants	Kelp	whole	raw	IN20	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Kelp	whole	raw	IN19	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Mountain Sorrel	leaves & stem	raw	IN23	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Blackberries	berry	raw	IN90	Hopedale	Oct. 1998	Dec 1998
	Blackberries	berry	raw	IN84	Mittimatilik Inlet	Aug. 1998	Dec 1998
	Blackberries	berry	raw	IN113	Rigolet	Sept. 1998	Dec 1998
	Blackberries	berry	raw	IN22	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Blackberries	berry	raw	IN45	Baker Lake	Aug. 1998	Dec 1998
	Blueberries	berry	raw	IN85	Mittimatilik	Aug. 1998	Dec 1998
	Blueberries	berry	raw	IN116	Holman	Aug 1998	Dec 1998
	Blueberries	berry	raw	IN92	Hopedale	Oct. 1998	Dec 1998
	Cranberries	berry	raw	IN59	Chesterfield Inlet	Aug. 1998	Dec 1998
	Cranberries	berry	raw	IN91	Hopedale	Oct. 1998	Dec 1998
Bird	Ptarmigan	meat	raw	IN105	Rigolet	Fall 1998	Dec 1998
	Ptarmigan	whole	boiled	IN115	Rigolet	March 1998	Dec 1998
Land Mammals	Caribou	heart	raw	IN149	Mittimatilik	Feb 1999	April 1999
	Caribou	heart	raw	IN179	Mittimatilik	March 1999	April 1999
	Caribou	heart	raw	IN165	Mittimatilik	March 1999	April 1999
	Caribou	kidney	raw	IN29	Aklavik	Oct. 1998	Dec 1998
	Caribou	kidney	raw	IN42,44	Paulatuk	Sept. 1998	Dec 1998
	Caribou	kidney	boiled	IN42,44	Paulatuk	Sept. 1998	Dec 1998
	Caribou	kidney	boiled	IN43,30	Aklavik/ Paulatuk	Oct. 1998	Dec 1998
	Caribou	liver	raw	IN96	Hopedale	Nov. 1998	Dec 1998
	Caribou	liver	raw	IN153	Mittimatilik	March 1999	April 1999
	Caribou	liver	raw	IN166	Mittimatilik	March 1999	April 1999
	Caribou	liver	raw	IN170	Mittimatilik	March 1999	April 1999
	Caribou	meat	raw	IN48	Baker Lake	Oct. 1998	Dec 1998
	Caribou	stomach	raw	IN169	Mittimatilik	March 1999	April 1999
	Caribou	stomach	raw	IN151	Mittimatilik	March 1999	April 1999
	Caribou	stomach	raw	IN167	Mittimatilik	March 1999	April 1999
	Caribou	stomach	raw	IN171	Mittimatilik	March 1999	April 1999
	Caribou	stomach	raw	IN173	Mittimatilik	March 1999	April 1999

Appendix C. Sample Profile

Food category	Common Name	Part	Prepared State	Code	Community	Harvest Date	CINE Lab Arrival
Land Mammals	Caribou	stomach	raw	IN150	Mittimatilik	March 1999	April 1999
	Caribou	stomach	contents	IN168	Mittimatilik	March 1999	April 1999
	Caribou	stomach	contents	IN152	Mittimatilik	March 1999	April 1999
	Caribou	stomach	contents	IN172	Mittimatilik	March 1999	April 1999
Marine Mammals	Beluga	muktuk	raw	IN6	Qikiqtarjuaq	Sept. 1998	April 1999
	Beluga	muktuk	raw	IN140	Mittimatilik	Aug. 1998	April 1999
	Beluga	muktuk	raw	IN211	Igloolik	August 1998	April 1999
	Beluga	muktuk	raw	IN209	Resolute	August 1998	April 1999
	Beluga	muktuk	raw	IN202	Tuktoyaktuk	August 1998	April 1999
	Beluga	muktuk	raw	IN200	Aklavik	August 1998	April 1999
	Beluga	muktuk	boiled	IN34	Hendriksen Island	July 1998	Dec 1998
	Beluga	muktuk	boiled	IN37	Hendriksen Island	July 1998	Dec 1998
	Beluga	meat	dried	IN4	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Narwhal	muktuk	raw	IN1	Mittimatilik	Aug 1998	Dec 1998
	Narwhal	muktuk	raw	IN3	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Narwhal	muktuk	raw	IN212	Resolute	August 1998	April 1999
	Narwhal	muktuk	raw	IN145	Mittimatilik	Aug. 1998	Dec 1998
	Narwhal	muktuk	raw	IN141	Mittimatilik	Aug. 1998	Dec 1998
	Narwhal	muktuk	raw	IN138	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Narwhal	muktuk	aged	IN183	Mittimatilik	March 1999	April 1999
	Narwhal	muktuk	aged	IN184	Qikiqtarjuaq	March 1999	April 1999
	R. Seal	blood	raw	IN204	Igloolik	March 1999	April 1999
	R. Seal	blood	raw	IN161	Mittimatilik	March 1999	April 1999
	R. Seal	blood	raw	IN157	Mittimatilik	March 1999	April 1999
	R. Seal	blood	raw	IN208	Igloolik	March 1999	April 1999
	R. Seal	blood	raw	IN164	Mittimatilik	March 1999	April 1999
	R. Seal	blood	raw	IN148	Mittimatilik	March 1999	April 1999
	R. Seal	brain	raw	IN24	Qikiqtarjuaq	Sept. 1998	Dec 1998
	R. Seal	brain	raw	IN163	Mittimatilik	March 1999	April 1999
	R. Seal	brain	raw	IN162	Mittimatilik	March 1999	April 1999
	R. Seal	brain	raw	IN160	Mittimatilik	March 1999	April 1999
	R. Seal	eye	raw	IN10	Qikiqtarjuaq	Sept. 1998	Dec 1998
	R. Seal	eye	raw	IN82	Mittimatilik	Oct. 1998	Dec 1998
	R. Seal	eye	raw	IN79	Mittimatilik	Oct. 1998	Dec 1998
	R. Seal	liver	raw	IN71	Igloolik	Oct. 1998	Dec 1998
	R. Seal	liver	raw	IN66	Igloolik	Oct. 1998	Dec 1998
	R. Seal	liver	raw	IN17	Qikiqtarjuaq	Sept. 1998	Dec 1998
	R. Seal	meat	raw	IN67	Igloolik	Oct. 1998	Dec 1998
	R. Seal	meat	raw	IN70	Igloolik	Oct. 1998	Dec 1998
	R. Seal	meat	raw	IN16	Qikiqtarjuaq	Sept. 1998	Dec 1998
	B. Seal	meat	boiled	IN87	Mitimatilik	Oct. 1998	Dec 1998
	B. Seal	meat	boiled	IN11	Qikiqtarjuaq	Sept. 1998	Dec 1998
	B. Seal	intestines	boiled	IN86	Mittimatilik	Oct. 1998	Dec 1998
	B. Seal	intestines	boiled	IN12	Qikiqtarjuaq	Sept. 1998	Dec 1998
	Walrus	kauk	raw	IN55	Chesterfield Inlet	April 1998	Dec 1998
	Walrus	meat	aged	IN88	Mittimatilik	July 1998	Dec 1998
	Walrus	meat	raw	IN52	Chesterfield Inlet	April 1998	Dec 1998

Appendix D. Use of Non-Fortified (NF) and Fortified (F) Juice Crystals

ID	*July 1987 (7)*	*Sept. 1987 (9)*	*Nov. 1987 (11)*	*Jan. 1988 (1)*	*March 1988 (3)*	*May 1988 (5)*
23			NF	none	F	NF
42	NF		F	F	none	none
62				none	none	NF
172	NF				NF	
182	F	F	NF	F	NF	NF
192		NF	F			none
202	NF	NF	NF			F
373			F		F	F
432	F				none	
442	F		NF		F	NF
482				NF	none	NF
492	NF	NF		F	NF	F & NF
513				F		NF
544	NF & F				NF	none
563		NF	NF			
623	NF	NF				
673				NF		
693		F	F	F		F & NF
744		NF	NF			
763		NF		none		
782		F & NF	F	NF		
801			none	NF	NF	none
822	F			F & NF	NF	
832		F				
833		NF				
841		NF			NF	
853			none	NF		
1082	NF	F	F	F & NF	NF	none
1113			NF			
1123	NF	F & NF		NF	F	none
1214	NF					
1332				NF	none	
3813			F			
3822			NF			
6312	NF			F & NF	none	
6322			none	F & NF	F	
7512						F
7712			F	F	NF & F	F
7723		F	none			
7724			NF			
9322			NF			
830002					none	NF

Appendix E. Traditional Food Codes & Vitamin C Values

Code	Food	Preparation	Vitamin C (mg/100g)	Imputed Code
4192	Cranberries	raw	3.88	
4047	Blueberries	raw	26.20	
4046	Blackberries	raw	2.41	
4050	Sorrel	raw	41.57	
4045	Kelp	raw	16.36	
4001	R. Seal meat	raw	1.55	
4004	R. Seal blubber	raw	0.00	
4054	R. Seal meat	boiled	1.19	
4079	R. Seal meat	aged	0.85*	*4067 (walrus)
4003	R. Seal liver	raw	23.80	
4057	R. Seal flippers	aged	0.85*	*4067 (walrus)
4059	R. Seal brain	raw	14.86	
4060	R. Seal eye	raw	3.17	
4058	R. Seal heart	raw	2.36*	*4086 (caribou)
4056	R. Seal broth	boiled	0.00	
4090	R. Seal pup meat	raw	1.55*	*4001
4092	R. Seal pup meat	boiled	1.19*	*4054
4005	B. Seal meat	raw	1.55*	*4001
4006	B. Sealblubber	raw	0.00	
4061	B. Seal meat	boiled	0.95	
4080	B. Seal meat	dried	0.85*	*4067
4062	B. Seal intestines	boiled	6.12	
4018	Beluga blubber	raw	0.00	
4020	Beluga mattak	raw	36.00	
4017	Beluga meat	dried	1.14	
4013	Narwhal mattak	raw	31.50	
4014	Narwhal blubber	raw	0.00	
4015	Narwhal blubber	aged	0.00	
4064	Narwhal mattak	aged	20.68	
4065	Narwhal mattak	boiled	21.00*	*4013 (70%) calculated from beluga mattak raw and boiled
4013	Narwhal meat	dried	1.14*	*4017 (beluga)
4067	Walrus meat	aged	0.85	
4068	Walrus meat	boiled	0.50	*estimated from raw
4021	Walrus meat	raw	1.00	
4022	Walrus blubber	raw	0.00	
4023	Walrus blubber	aged	0.00	
4024	Walrus mattak/kauk	raw	0.70	
4069	Walrus mattak/kauk	aged	0.50*	*4024 (70%)
4027	Caribou meat	raw	0.86	

Appendix E. Traditional Food Codes & Vitamin C Values				
Code	**Food**	**Preparation**	**Vitamin C (mg/100g)**	**Imputed Code**
4028	Caribou fat	raw	0.00	
4074	Caribou meat	boiled	0.50*	*estimated from raw (4027)
4073	Caribou meat	dried	0.50*	*estimated from raw (4027)
4086	Caribou heart	raw	2.36	
4087	Caribou lungs	raw	2.36*	*4086
4083	Caribou tongue	raw	2.36*	*4086
4085	Caribou stomach contents	raw	1.01	
4084	Caribou stomach	raw	0.45	
4032	Arctic char meat	raw	1.23	
4075	Arctic char meat	boiled	0.9*	*4032 calculated from Whitefish
4076	Arctic char meat	dried	1.0*	*estimated
4033	Arctic char skin	raw	1.0*	*estimated
4088	Arctic char skin	boiled	1.0*	*estimated
4043	Mussels	raw	3.69*	*4044
4078	Clams	boiled	2.75*	*estimated from 4044 (75%)
4044	Clams	raw	3.69	
4034	Sculpin meat	raw	1.05	
4037	Ptarmigan meat	raw	1.70	
4089	Duck meat	boiled	1.27*	*estimated from 4037 (75%)
4039	Duck meat	raw/boiled	1.27*	*estimated from 4037 (75%)
4042	Duck eggs	raw	0.00*	*domestic USDA, 1998
4036	Arctic hare meat	raw	0.86	*estimated from 4027 (caribou)

Appendix F. UCB Mini-list Codes And Vitamin C Values - Adjusted For Canadian Nutrient Data File (CNDF 1991)			
Code	**Name**	**Vitamin C mg/100 g**	**Vitamin C Values Adjusted for CNDF 1991**
8	Almonds	1	
13	Apple raw	6	
27	Apple juice frozen	33	*
29	Applesauce cnd	2	
126	Bacon cured cooked drained	0	*
141	Banana	9	
156	Beans baked cnd w pork & tomato	3	
186	Beans snap green cnd drained	5	
353	Beef round broiled	0	
370	Beef hamburger	0	
371	Beef & Veg stew	7	
377	Beef corned cnd	0	*
379	Hash, corned beef cnd	0	
383	Beef potpie com frozen	0	
396	Whiskey	0	
404	Cola carbonated	0	
407	Gingerale carbonated	0	
416	Biscuits made from mix	0	
434	Soup, beef broth or bouillon	0	
461	Bread white enriched	0	
505	Butter	0	
512	Cabbage raw	47	
513	Cabbage shredded boiled	24	
539	Cake pound	0	
547	Cake devil	0	
550	Cake angelfood	0	
554	Cake coffeecake	0	
569	Cake yellow	0	
581	Caramels	0	
587	Chocolate	0	
619	Carrots raw	9	
620	Carrots boiled drd	2	
643	Cheese blue	0	
646	Cheese cheddar	0	
649	Cheese cream	0	
653	Cheese american pasteurized	0	
689	Chicken fryers flesh & skin fried	0	
747	Chicken cnd bnd	2	
756	Chili con carne/beans	1	*
780	Cocoa mix	0	*
800	coffee instant	0	
812	Cookies assorted	0	
820	Cookies fig bars	0	
845	Corn sweet boiled drained	6	
847	Corn sweet cream style	5	
850	Corn sweet cnd drained	5	*
857	Corn sweet boiled drained	3	

Appendix F. UCB Mini-list Codes And Vitamin C Values - Adjusted For Canadian Nutrient Data File (CNDF 1991)			
Code	**Name**	**Vitamin C mg/100 g**	**Vitamin C Values Adjusted for CNDF 1991**
866	Corn flakes add nut	0	*
914	Crackers graham	0	
916	Crackers saltine	0	
929	Cream light	1	
958	Doughnuts	0	
974	Eggs-whole hard bld	0	
977	Eggs-scrambled	0	
999	Fat vegetable	0	
1017	Fishsticks frzn ckd	0	
1032	Gelatin plain	0	
1100	Fish, battered, fried	0	
1134	Honey	0	
1140	Ice cream	1	
1149	Jellies	0	*
1190	Lamb leg, roasted	0	
1241	Lard	0	
1252	Lemonaide, Koolaid	0	
1258	Lettuce	4	
1304	Macaroni ckd	0.3	
1317	Margarine	0	
1320	Milk whole	1	
1322	Milk skim	1	
1323	Milk, part skim	1	
1324	Milk evap. cnd	16	
1328	Milk dry nonfat solids	6	
1340	Molasses med	0	
1355	Mushrooms cnd	0	
1375	Mustard yellow	0	
1378	Noodles enr	0	
1391	Oats rolled	0	
1413	Onions bld, drd	5	
1420	Orange raw	53	
1437	Orange jcd frzn dilt	39	
1446	Oysters cnd	5	
1457	Pancakes	1	
1493	Peanuts	0	
1497	Peanut butter	0	
1518	Peas cnd drd	10	
1546	Peppers swt grn bld	74	
1561	Pickle cucumber	1	
1566	Pie apple	1	
1611	Pineapple raw	15	
1616	Pineapple cnd	7	
1633	Pizza w cheese	7	

Appendix F. UCB Mini-list Codes And Vitamin C Values - Adjusted For Canadian Nutrient Data File (CNDF 1991)			
Code	**Name**	**Vitamin C mg/100 g**	**Vitamin C Values Adjusted for CNDF 1991**
1636	Frzn dinner-chk,pot,veg	4	
1638	Frzn dinner-tky. pot,veg	4	
1654	Popcorn	0	
1683	Pork lean	0	*
1783	Pork ham cnd	0	
1786	Potatoes bkd w skin	13	
1788	Potatoes bld	7	
1789	Potatoes fried	11	
1793	Potato mashed	6	
1809	Potato chips	58	0
1826	pudding	1	
1846	Raisins	3	
1872	Rice white	0	
1938	Mayonnaise	0	
1940	Salad dressing	0	
1963	Salt	0	
1972	Sardines cnd oil	0	
1999	Frankfurters	0	
2014	Pork sausage ckd	0	
2018	Salami ckd	0	
2049	Sirup	0	
2051	Sirup corn	0	
2075	Soup cream chicken	1	
2079	Soup chic noodle	0	
2099	Soup tomato	2	
2104	Soup veg beef	0	
2156	Soy sauce	0	
2159	Spaghetti enr ckd	0	
2164	Spag cnd w tom. cheese	4	
2165	Spag-meat, tom home	9	
2229	Sugar	0	
2230	Sugar gran	0	
2277	Tea	0	
2282	Tom Ripe	19	
2284	Tom cnd	15	
2286	Catsup	15	
2404	Veg mix frzn boiled drained	3	
2421	Walnuts	3	
2439	Wheat flour	0	
2456	Wheat flakes cereal	0	
2600	Gravy meat brn	0	
2701	Oil corn	0	
3500	Juice-powder-fortified	25	

Appendix G . Edible Weights Of Inuit Traditional Food (kg)

Animal	Part	Foote (1967)	Stewart & Stahl (1977)	Binford (1978)	CINE	Freeman (1970,2000)	Riewe (1977)	Savelle & McCartney (1988)	Weight used
R. Seal	whole	45.5	92.5			40	48		45 - 92
	meat	12.3	23.9			14	14		12 - 14
	liver		2.7						2
	eyes				0.05				0.05
	heart		0.68						0.7
	brain				0.3				0.3
	kidney		0.45						0.5
	blubber	14.6	38.5				15		15 - 38
	blood	2.25							2
	intestines								4 est.
	viscera						8		8
B. Seal	whole	273				270			273
	meat	68.3				27			27 - 68
	viscera	24.6							24.6
	heart								1 est.
	intestines								4 est.
	blubber	73.1							73
Beluga	total	454				450	450		450 - 600
	meat	77.2				138			138
	heart					7.2			7.2
	kidney					7.5			7.5
	liver					15			15
	stomach					40			40
	intestines								33 est.
	organs	104							
	mattak	77.2				62			77
	blubber	113.5				90			90 -113
Narwhal	whole						540		540
	meat								77-138 (beluga)
	liver								15 (beluga)
	mattak								77 (beluga)
	viscera								104 (beluga)
	blubber								90-113 (beluga)
Bowhead	whole	27,240						10,000	10 - 27,000
	meat	4,631							1700 - 4500
	liver								450
	mattak	4,631							1700 - 4600
	blubber	10896							4 - 10896
Polar bear	whole	363.6				365			365
	meat	125				45 - 165	80*		45 - 165
	blubber						100		
Walrus-adult	whole	682				512			305 - 512
	meat	238.7				25*	30*		25 - 239

Appendix G . Edible Weights Of Inuit Traditional Food (kg)

Animal	Part	Foote (1967)	Stewart & Stahl (1977)	Binford (1978)	CINE	Freeman (1970,2000)	Riewe (1977)	Saville & McCartney (1988)	Weight used
Walrus - adult	viscera	177.3							177
	skin	81.4							81
	heart								7 (beluga)
	intestines								10 (beluga)
	liver								15 (beluga)
	blubber	109.1							109
Walrus - subadult	whole					305			305
	meat					61*			61
Walrus - calf	whole					103			103
	meat					20*			20
Caribou	total	68.2		110					68-110
	meat	23.9		43 c fat					24
	kidneys				0.4				0.4
	liver			1.2	1.0				1.2
	tongue			1.0	0.3				0.3
	heart			0.7					0.7
	lungs			2.05					2.05
	stomach & content			21	8				2 - 4 6 - 17 contents
	fat	6.8							7-20 (Spiess)
Arctic Hare	whole	1.46							1.46
	meat	0.68							0.68
Arctic Fox	meat						1.5		1.5
Ptarmigan	whole	0.9			0.4				0.4 - 0.9
	meat	0.63							0.4 - 0.63
Eider	whole	1.6							1.6
	meat	1.1							1.1
Murre	whole	0.96							0.96
	meat+ organs	0.67							0.4 est.
Duck	meat								0.5 est.
Arctic Char	meat	0.45							0.45 -1 est.
	eggs								0.2 est

* Weights significantly lower as actual weights adjusted for human/dog. Weights reflect human use.

Appendix H Interview Questions used in Mittimatilik

Role of traditional/market food.

What does it mean do be healthy? Can you tell me how one maintains healthy?

Can you tell me about your needs for traditional food?

What is important about traditional food?

Are these foods different if they are eaten fresh, have been frozen for months, boiled, dried?

Are they more preferred, less...

Changes in use of traditional food

Can you tell me about your memories of food at camp. Was what you ate different than from what you eat today?

Are there traditional foods that are no longer eaten in the same amounts or at all?

Are they less available or not preferred?

Are wild plants or berries collected for food?

If yes, which ones. (Land and sea plants) (**Aid of fieldguide**)

Has their harvesting/use changed?

Are there any plants that are no longer collected?

During the winter were any plants, berries harvested in the summer still available to eat?

How long into the winter might there still be any stored plants available?

How often might these be eaten?

Food Availability

What traditional food might you have available throughout the winter, early spring?

Are foods such as mattak available for most of the year?

Food Preparation & Storage

If traditional food are cooked, what are some common methods?

Are traditional foods often cooked?

Do you remember in your parents, grandparents time if food was stored differently than it is today?

Knowledge re: vitamins, vitamin C.

Do you eat any food in part because it has vitamins

Do people you know take vitamins?

Do you know of food that has vitamin C?

Are there any foods bought/eaten because they contain vitamin C?

Historical knowledge of food as medicine

What are some illnesses that you recall happening to people in the past in camps?

Do you recall problems of illness in the camp?, such as people with sore gums/teeth and weakness, developing among people in the community/camp?

Are there traditional foods that are considered medicine? What are they used to treat