PROXIMATE NUTRIENT CONTENTS IN SOME SELECTED VEGETABLES

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CERTIFICATE

This is to certify that the thesis entitled, "***Proximate Nutrient Contents in Some Selected Vegetables***" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfillment of the requirements for the degree of ***MASTER OF SCIENCE IN AGRICULTURAL CHEMISTRY,*** embodies the result of a piece of *bona fide* research work carried out by ***MD. HELAL UDDIN,*** Registration No.***08-03181*** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

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ABSTRACT

The present study was considered to investigate the nutritional quality of fifteen leafy and fruit vegetables grown in Bangladesh. The experiment was done on fifteen vegetables *viz. Amaranthus gangeticus* (Lalshak)), *Amaranthus lividus* (Danta), *Raphanus sativus* (Mulashak)), *Momordica charantia* (Karola), *Trichosanthes dioica* (Potal), *Solanum tuberosum* (Alu), *Lablab niger* (Sheem), *Dacus carota* (Carrot), *Lycopersicon esculentum* (Green and ripe tomato), *Brassica oleracea var botrytis* (Phulkopi), *Brassica oleracea var capitata* (Bandhakopi), *Raphanus sativus* (Mula) and *Chenopodium album* (Goose foot) and Amrul leaf. The experiment was laid out in a single factor completely randomized design with three replications. The vegetables were collected from local markets of Dhaka city. Observations were made on nutritional quality characters like the contents of protein, fat, carbohydrate and minerals in the target vegetables. There was significant variation among the vegetables in respect of all the quality characters such as protein, fat, carbohydrate and mineral content. Results revealed that protein and fat content was greater in leafy vegetables than fruit vegetables. The higher moisture with less protein and fat content were recorded in case of fruit vegetables like Karola and Potal; Karola being the lowest in protein and fat 1.11 and 0.07% respectively. These results indicate that potato and radish contributes less to fulfill our nutritional requirement. The highest iron (4.33%) with higher protein (3.73%) content was recorded for Bothua. The highest fat (0.77%) with higher calcium (216%) content was found in country bean. Results revealed that in general, calcium, iron, and other mineral contents were greater in leafy vegetables than root and fruit vegetables except carrot. The highest iron and highest mineral content were recorded in Bothua followed by amrul leaves. The highest calcium with higher mineral content was found in country bean. Country bean, carrot, amrul and bothua stand out to be a good source for protein, fat, calcium, iron and minerals. Therefore, when measures are taken to improve food and nutrition security, there should be a focus on the production and consumption of lalshak, datashak and mulashak, Country bean, carrot, amrul and bothua.

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LIST OF ACRONYMS

FULL NAME	ABBREVIATION
At the rate of	@
And others	*et al.*
Bangladesh Bureau of Statistics	BBS
Benefit cost ratio	BCR
Cultivar	CV.
Degree in Celsius	^{o}C
Duncan's Multiple Range Test	DMRT
Date After Transplanting	DAT
Etcetera	etc
Food and Agricultural Organization	FAO
Hectare	ha
Hour	hr
Muriate of Potash	MP
Number	no.
Namely	viz.
Randomized Complete Block Design	RCBD
Sher-e-Bangla Agricultural University	SAU
Ton per hectare	t/ha
Triple Super Phosphate	TSP
That is	i.e.
Least significant Difference	LSD
Association of American Analytical Chemists	AOAC
Carbohydrate	CHO
Dietary Fiber	D. F.
Dhaka University	D U
Degree of Fahrenheit	^{o}F
Edible Portion	E. P.

DEDICATED TO

MY BELOVED PARENTS

CHAPTER I
INTRODUCTION

Bangladesh is an agro based country blessed with an inland area of 14.8 million hectares under an excellent ecological condition for the production of vegetables (AIS, 2011). About 63% of plant protein in our diet is supplied from vegetables (MoA, 2002). Many different small indigenous vegetables like Potato, Lalshak, Datashak, Mulashak, Karola, Potal, cabbage, Radish, Amrul leaf, Bothua etc were abundant in almost all areas of Bangladesh. These indigenous vegetables are favorite and popular for their taste (Moniruzzamman, 2000). These vegetables are most commonly consumed by all classes of people in Bangladesh. Fresh vegetables are important source of essential macro and micronutrients.

Information of the chemical composition of vegetables in respect of the nutritive value is important to compare it with the other source of nutrition like animal protein, meat and poultry products (Stansby, 1978). From recent epidemiological, clinical and nutritional studies on animal and human, it is accepted that vegetable fat contains high amount of unsaturated fatty acids which are responsible for preventing atherosclerosis, cardiovascular diseases, aging and certain forms of cancers (Kinsella, 1988; Morris and Culkin, 1989). Vegetables are excellent source of plant protein with all the essential dietary amino acids. Vegetables contain many important minerals like iron, calcium, phosphorous, zinc, copper, magnasium and vitamins.

In Bangladesh, vegetables provide the main and the cheapest source of plant protein in the diet of her population. The minimum per capita per day protein requirement in Bangladesh has been estimated at 45.30 g, of which 15 g should be of animal origin. Vegetables contribute about eighty percent (80 %) of the total plant protein intake (Rahman and Ali, 1986).

There are about 150-200 vegetables species that contribute enormously to the supply of essential nutrients in Bangladeshi diet (Zafri and Ahmed, 1981). Small indigenous vegetables are rich in vitamin -A. Some vegetables are fair sources of essential minerals in our diet (Marufa, 1998). Generally vegetables are not uniformly available in every region of the country (Islam, 1983). The consumption of vegetables increases with increasing income. Lower income groups maintain their consumption of vegetables mainly by buying. The study was to estimate the nutritional composition especially nutrients and their role in health of human being by determining these vegetables chemical composition.

1.1 Nutrient in vegetables

Vegetables are considered to be the potential source of protein, fat, vitamins and minerals. Most vegetables do not have appreciable carbohydrates. For all practical purposes, the calorie values of vegetables are based only on the fat and protein content. A few species have their fat predominantly in the form of wax-esters, instead of triglycerides. These wax-esters are believed to be resistant to digestion by human system so that their fat content would not contribute considerably to the calorie value of these vegetables (Nettleton, 1985). The biochemical composition of specific vegetables may vary within the same species of vegetables depending upon the season and habitat (Srivastava, 1985).

1.2 Protein

The cardinal virtues of all vegetables are their high quality protein. Vegetable protein is 85- 95 % digestible (Nilson, 1976). Having all the essential amino acids, vegetables protein has a very high biological value (Huss, 1988). All vegetables provide complete protein having all essential amino acids so that less of it is required by the body to meet its daily protein requirement. Cereal grains are usually low in lysine and sulphur containing amino acids (Metheionine and

Cysteine), whereas vegetable protein is an excellent source of these amino acids. In diets based mainly on cereals, a supplement of vegetables can raise the biological value significantly (Huss, 1988). As vegetable protein is highly digestible and easily absorbed in the body, people of all ages over a year to seniors can enjoy vegetables.

1.3 Fat

Most vegetables are relatively low in total fat and relatively high in its proportion of polyunsaturated fatty acids. This feature gives vegetables a clear health advantage (Nettleton, 1985). Fats, especially vegetable oils, contain an essential fatty acid called linoleic acid that the body can make for itself. The amount of linoleic acid required is small and is easily obtained from the foods and also we commonly eat, especially vegetables. It also appears that linoleic acid, a second fatty acid, is probably essential in humans (Neuringer *and* Conner 1984; Holman *et al.,* 1982). It may also be that omega- 3 fatty acids in vegetable oils are necessary for optimum health, especially for healthy heart (Titus *et al.,* 1982; Oliv *et al.,* 1983). Fats are made of different kinds of fatty acids. The body handles these fatty acids in different ways, which have implications for health. There is still a great deal to learn about how the body processes different fatty acids, but it seems clear that some fatty acids are more beneficial for health than others (Nettleton, 1985). In particular, polyunsaturated fatty acids have been shown to be more favorable for healthy blood lipid (fat) levels than saturated fats. In many people, achieving a better blood lipid pattern can lower the chances of heart attack or stroke (Grundy *et al.,* 1982). The best way to achieve a healthy blood lipids pattern is to eat less fat in total to limit the amount of saturated fats consumed and to keep cholesterol intake below 300 mg per day (Ernest, 1985).

1.4 Minerals

Vegetables are the important sources of essential minerals such as zinc, copper, iron, magnesium, calcium, phosphorus, sodium and potassium (Nettelton, 1985; Banu *et al.,* 1985; Rubbi et *al., 1987,* Banu *et al.,* 1991). Vegetables do provide a well-balanced supply of minerals in a readily usable form (Murry and Burt, 1992). In most species, the total mineral or ash content ranges from 1 to 2%. There are a wide variety of minerals in vegetables' flesh and they are usually present in a form, which is readily available (Clucas and Ward, 1996). Vegetables are regarded as a valuable source of calcium and phosphorus in particular, but also of iron and copper (Huss, 1988).

1.4.1. Iron (Fe)

Vegetables, especially the dark fleshed vegetables are good sources of iron (Nettleton, 1985). Iron in vegetables is heme iron (hemoglobin and myoglobin), which increase the absorption of iron (Anderson *et al.,* 1982). Iron plays an important role in cellular metabolism as an active component of various enzymes, especially those associated with the respiratory chain of the mitochondria. The essential functions of iron are oxygen transport and oxygen utilization through hemoglobin and myoglobin. Iron is an essential part of enzymes and immune substances needed to destroy invading infectious organisms. Anemia occurs due to the deficiency of iron. Recent evidence suggests that iron deficiency in human is closely related to the occurrence of infections (Stanley, *et al* 1957). Vegetables' iron is most effective in regenerating hemoglobin in cases of anemia (George and Borgstrom, 1962).

1.4.2 Calcium (Ca)

Vegetables are excellent sources of calcium (Nettleton, 1985). Calcium is a relatively inert inorganic mineral elements usually associated with bones and tooth formation (Whedon, 1982). Calcium plays an important role in the formation and maintenance of bone and tooth structure (Anderson *et al.,* 1982). Calcium is essential for the normal growth, bone formation, blood coagulation, milk formation, vitamin-D absorption etc. The body of an adult contains about 1200 g of Ca. At least 99 % of this amount is present in the skeleton, where calcium salts help in a cellular matrix to provide the hard structure of the bones and teeth (Stanley and Davidson, 1975). Calcium functions as catalysts in many biological reactions. The heartbeat is controlled by an electrical center called the "A-V" node; calcium is also involved in transmission of impulses in this center (Passwater and Cranteon, 1983). Calcium is important metabolically for the activity of certain enzymes, notably adenosine tri-phosphate in the release of energy for muscular contraction and for the activity of cyclic-AMP. In the blood clotting process, calcium must be present. The need for calcium is increased during pregnancy and lactation (Pitkin, 1975). During pregnancy, there is an increased demand for calcium by the growing fetus to the extent of 28g, 2/3rd of which is required in the last trimester (Dutta, 1986). Deficiency of calcium leads to rickets, osteomalacia and osteoporosis.

1.5 Nutrient situation in Bangladesh

Malnutrition is a major problem worldwide. It may be defined as a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients. This is due to lack of food, lack of proper knowledge and facilities, There are still millions of people in the world who are starving and underfed (Chaney- Ross and Finley, 1986). One of the major problems in the world today is the inadequacy of the food supply in relation to the magnitude of population growth. There is a wide gap between agricultural products and population expansion in the less-developed regions of the world (Chaney Ross and Finley, 1986). Magnitude of the problem of malnutrition is even greater in Bangladesh (Ahmed and Hassan, 1992). Two consecutive National Nutrition Surveys (Ahmad *et al.,* 1983; Ahmed and Hassan, 1992), in Bangladesh give poignant revelation to the fact that average Bangladeshi diet is grossly inadequate in terms of energy, protein, fat and micronutrients. Our protein and calorie intakes are less than optimum. Nutrients such as protein, fat, vitamin-A, iron, iodine, calcium, riboflavin and vitamin-C, are limiting in our diet. Traditional Bangladeshi diet is largely based on cereal products; contributions of animal products rich in vitamins and minerals is getting negligible or almost nil. Thus nutrient- malnutrition is widespread in Bangladesh. In Bangladesh the problem is especially acute in respect of protein, fat, vitamin-A, iron and iodine. About 80% of the populations do not get the required daily energy intake, the average intake being only 1950 kilocalorie per day, while the FAO recommendation is 2310 kcal per day. Protein deficiency is a similar problem with 77 % of the population suffering from insufficient protein intake (Ministry of Health and Family Planning), 1992. Average daily intake of vitamin -A is very low and has declined from 870 IU in 1962-64 to 703 IU in 1981-82 (Ahmad and Hassan, 1992). The main reason for protein deficiency in Bangladesh is an inadequate intake of the vegetables through diet.

About' 50-70% of our children die within a few months of the blinding episodes (Cohen, 1989). The prevalence of night blindness due to vitamin-A deficiency is 1.7%, which is well above WHO- criteria, making it a serious public health problem (Ministry of Health and Family Planning, 1992). Anemia is another nutritional catastrophe in Bangladesh. About 70% women and children, nearly 80% of pregnant woman and 60% of men have anemia mostly due to effective iron deficiency (Ahmed and Hassan, 1992). Nearly 70% of the populations have physiological iodine deficiency, 47% already have goiter and about 500,000 people are cretin (Yusuf *et al.,* 1993). Deficiency of riboflavin, vitamin-C, zinc, calcium and some other micronutrients are also common in Bangladesh. However deficiency - effects of these micronutrients are not as severe as in case of vitamin-A, iron and iodine deficiency. These statistics are enough to predict what great devastating tragedy is lying ahead of the nation. The loss of human resource potential caused by these micronutrient deficiencies is beyond measure by physical scale. Bangladesh is poised to incur an enormous economic loss every year, if these problems are not addressed immediately. Short-term measures such as vitamin- A week, iron-folate supplementation and universal salt iodination seem appropriate in this regard, but they cannot be the sustainable solution to these human scourges. Except for iodine deficiency, the ultimate solution to other micronutrient deficiencies must be one based on food. People should be made empowered enough and aware enough to consume those foods, which are rich in micronutrients. However, for a poor country like ours, the food of choice should be cheap as well as nutritious. Green leafy vegetables (GIV) and indigenous fish seem to be quite promising as the sources for nutrients, vitamins and minerals in our habitual diet. Most of the vegetables are rich source of protein. Thus in the content of nutrition situation prevailing in Bangladesh, indigenous vegetables might be a viable access to the supply of essential nutrients in our diet. In this way, we can reduce our malnutrition problem and be able to make a healthy nation.

Dietary assessment is regarded as one of the important methods for determining the nutritional status of an individual or a community as a whole. Dietary assessment has to be done based on a local food composition data specific for a particular region, because nutrient content of food materials may differ largely due to regional variation. Rice and fish are our staple food. 'In spite of a larger consumption of vegetables amongst our people, information as regards their content of essential minerals and vitamins are scarcely available in our scientific literature. For want of necessary data on mineral content of Bangladeshi foodstuffs, assessment for dietary intake of essential minerals and vitamins could have not been made in several previous surveys conducted in Bangladesh. The present available values on this account are already fifty years old and the foodstuffs were not analyzed for many essential micronutrients, vitamins and minerals. This situation calls for an update on these values. Bangladesh is a poor country having a large population. Most of the people of our country live below the poverty line. A bunch of people are ultra poor. Very often we need to arrange mass feeding programs for them. Nutrient values of the foodstuffs are very much essential to determine the amount of food required to implement such programs. Even at the home level, to prepare balanced diet, nutrient value of different foodstuffs are required to determine the amount of them to be eaten for healthy and active life. The nutrient values, those are currently being used for these purposes are very old and many of them have been copied from Indian food composition table. Since the soil and climate of India and Bangladesh are not all the same, there might be a considerable difference in the nutrient values of the foodstuffs.

1.6. Specific Objectives:

i) To estimate the protein, carbohydrate and fat contents of selected vegetables per 100g edible portions,

ii) To observe the calcium and iron contents of selected vegetables per 100g edible portions.

CHAPTER II

REVIEW OF LITERATURE

Although leafy and fruit vegetables are important of tropics and sub-tropics, considerable literature dealing with quality characters of Lalshak, Datashak, Mulashak, Karola, Potal, Potato, Country bean, Carrot, Tomato (Green), Tomato (Ripe), Cauliflower, Cabbage, Radish, Amrul leaf, Bothua are very limited. An attempt has been made in this chapter to review the pertinent research work related to the present study.

Green vegetables include both leafy and non-leafy vegetables. These are excellent sources of several vitamins and minerals. This is particularly true of the green (and yellow) leaves. Vitamin A content increases with greenness. They contain a large amount of indigestible fiber called 'roughage'. Green leafy vegetables are also very good sources of fiber, complex carbohydrates, and calcium.

Basu (1947) investigated the chemical composition of several varieties fruits cultivated in India in the unripe and stages to examine the relationship between nutritive value and chemical constitute of the fruits. They found that unripe fruits contain more vitamin-C and ripe fruits are richer source of sugar and carotene, the precursor of vitamin-A. The main constituents of fruits and vegetables are water (moisture), carbohydrate, protein, fats, minerals, pigments, acids and vitamins. Substances collectively forming its flavors. Through water and carbohydrates from the main component, the others even excluding its fats and proteins, contributing a deal to the food valued of fruits and vegetables, described by Czyhrinciw (1955).

Mukerjee (1960) examined several physical, morphological and chemical indices in vegetables for defining maturity of harvest. A survey was arrange northern Nigeria and selected sixteen local and seven introduced varieties of selected fruits based on morphological characteristics and time of harvest.

Lakshiminarayna (1970) reported that selected fruits and vegetables are usually harvested unripe before the onset of the climacteric, but physiologically mature. The authors also stated that later harvest (tree ripe) fruits ripens unevenly post harvest and has lower sugar, acid ratios. Selected fruits and vegetables are not allowed to ripen on the tree because of

- The economic aspects of the majority of fruits droop from the tree or exposed before they are ripe enough for consumption and
- Tree ripe fruits are inferior in taste and aroma to fruit that ripens after harvest and their keeping qualities reduced stated by Subramanian *et. al* (1971).

Propane *et al.* (1958) and Lakshiminarayna (1970) reported by physical, chemical and physiological parameters have been examined to define optimum stage of maturity harvest of vegetables. Useful chemical parameters reported are soluble solids content acid, carbohydrate (Sugar, Starch) content.

Koubala and Mbome (2003) also studied the physico-chemical properties for observed the effect of ripening on the composition and the suitability for jam processing of different varieties of vegetables.

Granda *et al.* (2005) stated that subjecting foods to high temperatures during cooking processes such as frying gives rise to the formation of acrylamide. Several factors including product composition and processing conditions affect the rate of formation of this chemical in starch-rich foods. Low reducing sugar and the amino acid asparagine content is desired when cooking because the formation of acrylamide is attributed to the Maillard reaction that occurs between these food components.

Zdravkovic *et al.* (2007) stated that Lycopene production in patal vegetable depends upon potassium ion concentration in cytoplasms and vacuoles, and other limiting factors, such as temperature, watering regime and direct sunlight, in cohesion with other factors. An industrial patal cultivar, Narvik SPF, was used to determine whether lycopene and beta -carotene production depend upon mineral macronutrient (potassium and phosphorus fertilizers). The content of lycopene regarding the fertilizer formulation ranged from 33.69 mg/kg in the control to 56.92 mg/kg in plants treated with increased content of potassium. Fertilizers with increased content of phosphorus increased the content of lycopene, compared to the control, but not significantly. On the other hand, this treatment provoked greater content of beta -carotene, which could be the cause of shortened vegetables maturing process (vegetables have been picked at the same day). Plants with the lowest content of beta -carotene had been treated with increased potassium (2.933 mg/g), which could be the cause of this shortened maturing process influenced by potassium ions, i.e. most of the beta -carotenes transformed into lycopene.

Rousseaux *et al*. (2005) observed that the aim of the present study was to evaluate the effect of substituting lean meat with fat meat on oxidative stress in a diet with or without fruit and vegetables. Methods: Thirty-two pigs were divided into groups and fed isocaloric daily rations: LM+FV (balanced diet with lean meat and fruit and vegetables); FM+FV (as LM+FV, but lean meat was substituted with fat meat); LM-FV (as LM+FV, but without fruit and vegetables), and FM-FV (as FM+FV, but without fruit and vegetables). Oxidative stress was evaluated by measuring the 24-hour urine malondialdehyde excretion rate, the degree of leukocyte nuclear DNA damage, the concentration of tocopherols in blood plasma, erythrocyte glutathione peroxidase activity and the total antioxidant status of plasma. Results: The substitution of lean meat with fat meat modestly increased the rate of leukocyte DNA damage only in the diet with fruit and vegetables but had no effect in the group deprived of fruit and vegetables. Regardless of the fruit and vegetable content of the diet, the substitution of lean meat with fat meat did not affect any other parameters measured. In comparison to both fruit- and vegetable-containing diets, the deprivation of fruits and vegetables in the LM-FV and FM-FV groups significantly increased the rate of leukocyte DNA damage and reduced the plasma alpha-tocopherol level (significant only for FM+FV). Conclusion: The substitution of fat meat with lean meat in a diet with or without fruit and vegetables has only a marginal or no effect on oxidative stress. But fruit and vegetable exclusion markedly increased the level of oxidative stress.

Sajitha -J-P *et al.* (2007) stated that the impact of organic manures along with biofertilizers as a substitute to chemical fertilizers for garden bean variety 'Konkan Bushan' was studied at Olericulture unit, Department of Horticulture, Faculty of Agriculture, Annamalai University during 2003-2005. Among the treatments tested inoculation of Rhizobium and vesicular arbuscular mycorrhizae (VAM) along with vermicompost and vermiwash yielded better than uninoculated and controlled treatments. As a result of increased nutrient uptake, nodulation and biological nitrogen fixation of Rhizobium, colonization of VAM and supplementation of nutrients through vermiwash and vermicompost derived from vegetable waste was found to be superior. The treatment supplied with Rhizobium and VAM along with flower waste vermicompost and spraying of vermiwash registered the highest protein content. The treatment which received with pressmud based vermicompost, biofertilizers and vermiwash recorded the highest fibre content. These results indicate that the garden bean being responds very well for inoculation of Rhizobium, VAM, and vermicompost and its wash for providing all necessary nutrients in available form.

Kalia, *et al.* (2007) reported that Greater knowledge of the magnitude of genetic variability for quantitative and quality characters in winter bean and relationships among these would facilitate the breeding improvement of this underutilized legume vegetable. Accordingly, a set of 24 genotypes/landraces was grown in a replicated experiment to assess genetic variation for pod yield and its component traits, ascorbic acid and protein content and quantify relationships among those traits. Significant differences among genotypes showed sufficient variability for the twelve traits studied that could be exploited in breeding. The differences in genotypic and phenotypic coefficients of variation (GCV and PCV) were negligible for days to 50% flowering, plant height, pod length, pod yield per plant, ascorbic acid and protein content, indicating little influence of environment on these characters. High heritability along with high genetic advance in case of pod yield per plant (H2< sub>bs</ sub>=97%; GA=126%) and node per plant (85%, 54%) indicated predominance of additive gene action in these traits. Non-additive gene action, however, appears to govern other parameters. Genotypic correlations among all the traits were higher than corresponding phenotypic correlations, indicating inherent associations among the traits. The highest positive phenotypic and genotypic correlations were between nodes per plant and pod bearing nodes per plant (rp=92*; rg=99) followed by pod yield per plant and nodes per plant (rp=86*; rg=93). Path coefficient analysis revealed that nodes per plant had the highest positive direct effect on pod yield per plant at phenotypic level (0.391) followed by branches per plant (0.108). However, at genotypic level, branches per plant had highest positive direct effect on pod yield per plant (3.286) followed by nodes per plant (2.811). Adequate genetic variability was present within the genotypes studied to allow breeding improvement of quantitative as well as quality traits. Selection for nodes and branches per plant would be the most effective means of indirectly increasing the pod yield in winter vegetables.

Hwang (2006) reported that the cruciferous vegetables such as Chinese cabbages and broccoli are known to have anticancer phytochemicals, and the consumption of cruciferous vegetables has been proposed for protection against various cancers. The anticarcinogenic properties of some Chinese cabbage extracts and sulforaphane glucosinolate (SFN) were assessed by examining their ability to prevent the inhibition of gap junctional intercellular communication (GJIC) induced by hydrogen peroxide (H_2O_2) in WB-F344 normal rat liver epithelial cells. The cells were preincubated with Chinese cabbage extracts and SFN for 24 h followed by cotreatment with cells and H_2O_2 (750 micromolar) for 1 h. Chinese cabbage extracts and SFN prevented the inhibition of GJIC and phosphorylation of gap junction protein connexin43 (Cx43) by H_2O_2 treatment. Chinese cabbage extracts and SFN were able to prevent the inhibition of GJIC through the blocking of Cx43 phosphorylaton and inactivation of ERK 1/2 and p38 MAP kinase. The results suggest that cruciferous vegetables and their components, SFN, may exert the anticancer effect by targeting the GJIC as a functional dietary chemopreventive agent.

Alvarez *et al.* (2005) reported that the parameters were lower in the samples thawed at 4°c than in those products by microwave at all the freezing temperatures used, which may be ascribed to gelatinisation of the starch released from damaged cells. Differences from the freshly prepared product decreased when the samples were frozen at -80°c and thawed by microwave. No difference was found in sensory acceptability between samples frozen at -80 and -40°c, which probably reflects the panellists' mixed preferences for air-thawed versus microwave-thawed samples. Increasing the time in frozen storage led to a natural mash with a firmer texture, higher L*/b* value and Brix; nonetheless, panellists found the samples at 0, 3 and 12 months of frozen storage equally acceptable. In commercial mash, penetration and oscillatory parameters showed that processing made for a firmer product than the fresh control, probably owing to retrogradation of gelatinised starch. Thawing mode had a significant effect on parameters, which were lower in the samples thawed at 4 °c the structure and quality of commercial mash was more detrimentally affected by freezing and, therefore, we would not recommend either freezing or frozen storage of this mashed potato in the used conditions. Natural mash made from Kennebec potatoes should be frozen quickly and thawed by microwave in the conditions described to obtain a product more similar to that freshly made. If the samples are frozen by air blasting at -40 °c the product can withstand frozen storage for one year.

Amin *et al.* (2005) stated that aimed to evaluate the effect of different blanching times on the antioxidant properties (antioxidant and free radical scavenging activities) and phenolic content of selected cruciferous vegetables. The study revealed that a 10-minute blanching time had a significant effect ($p < 0.05$) on the antioxidant properties and phenolic content of all the vegetables except for cabbage and mustard cabbage. The loss of antioxidant activity was highest in Chinese cabbage (40%) after 15 minute of blanching, followed by cabbage (27%), Chinese white cabbage (19%), mustard cabbage (9%) and red cabbage (4%). Red cabbage had lost a total of 40% scavenging activity after 15 minute of blanching followed by Chinese cabbage (38%), cabbage (36%), mustard cabbage (23%) and Chinese white cabbage (11%). Only Chinese cabbage showed an increase ($p < 0.05$) in total phenolic content after 15 minute of blanching compared with other vegetables. Minimal heat treatment through blanching process is recommended to prevent the major loss of antioxidant properties and phenolic content in selected cruciferous vegetables.

McConnell *et al.* (2005) reported that the increasing demand for freshly cut vegetables, a substantial potential exists in developing minimally processed sweet potato products. This study was undertaken to determine the effects of semipermeable polymeric materials and modified atmosphere packaging (MAP) on quality changes and microbial growth in shredded sweet potatoes under refrigerated storage. Shredded sweet potatoes from two major commercial cultivars (Beauregard and Hernandez) were packed in low and medium O_2 permeability bags and flushed with gas composed of 5% O_2, 4% $CO_2$and 91% N_2 Quality changes and microbial growth were monitored in comparison to the samples packed in air using high O_2 permeable films.

Richter *et al.* (2007) reported that Calystegines are hydroxylated nortropane alkaloids derived from the tropane alkaloid biosynthetic pathway. They are strong glycosidase inhibitors and occur in vegetables such as potatoes, tomatoes, and cabbage. Calystegine accumulation in root cultures was described to increase with carbohydrate availability. Whether this is indicative for the in planta situation is as yet unknown. Potatoes are model plants for the study of carbohydrate metabolism. Numerous transgenic potato lines with altered carbohydrate metabolism are available, but rarely were examined for alterations in secondary metabolism. In this study, calystegine accumulation and expression of biosynthetic enzymes were related to genetic modifications in carbohydrate metabolism in potato tubers. Tubers contained more soluble sugars due to overexpression of yeast invertase in the apoplast or in the cytosol, or due to antisense suppression of sucrose synthase. It is shown that the major part of calystegines in tubers originated from biosynthesis in plant roots. Yet, tuber calystegine levels responded to genetic alterations of carbohydrate metabolism in tubers. The strongest increase in calystegines was found in tubers with suppressed sucrose synthase activity. Transcripts and enzyme activities involved in calystegine biosynthesis largely concurred with product accumulation. Whole plant organs were examined similarly and displayed higher calystegines and corresponding enzyme activities in roots and stolons of plants with enhanced soluble sugars. Increases in calystegines appear to be linked to sucrose availability.

Charmley *et al.* (2007) stated that Potato (Solanum tuberosum) production in Canada and the United States totals approximately 30x106 tonnes year-1. Approximately half of this is unsuitable for human consumption. This potato byproduct comprises cull potatoes and potato processing waste (PPW). Liquid waste from processing plants can be applied to agricultural land. With strict environmental monitoring and control, crops such as maize (Zea mays), vegetables and grass can be used to divert large volumes of liquid waste. Solid waste and culls have traditionally been put in landfills or disposed of on agricultural land as a fertilizer. However these can be diverted from landfill sites or agricultural land and used as a high-quality animal feed, principally in beef feedlots. Research has shown that PPW can replace maize and barley (Hordeum vulgare) grain without negative effects on growth of beef cattle or meat quality. Indeed, efficiency of animal growth per unit diet intake is improved. These effects have been observed with diets containing up to 80% PPW. Results to date suggest that PPW is a valuable livestock feed ingredient and has no deleterious effects on beef quality. In areas where PPW is available, feeding to beef cattle represents a viable alternative to other disposal options.

Guo-ShuHua *et al.* (2007) reported that fruit specific promoter E8p1 was cloned from tomato (Lycopersicon esculentum) cultivar Hongmanao213. Plasmid pBI121 containing beta-glucuronidase (GUS) gene (gus) was used to construct the vector. Tomato cultivar Zhongshu4 was used for Agrobacterium-mediated transformation. Total DNA and total RNA was extracted from the pE8p1-gus transgenic plants. Results of PCR (polymerase chain reaction) and RT-PCR (reverse transcription PCR) confirmed that gus was integrated into the genome and was expressed only in matured fruits but not in the leaves. Histochemical examination was carried out on samples collected from these transgenic plants, which included leaves, anther, young fruits and mature fruits. GUS activity was detected from anther and mature fruits only.

Wen-Qin *et al.* (2007) observed that the correlation between the dielectric properties and the freshness of leafy vegetables was studied to evaluate the quality nondestructively. The dielectric properties were studied on four kinds of leaf vegetables with two plate electrodes during storage at room temperature. The results show that the dielectric constants and parameters for freshness decreased during 3-day storage of leaf vegetables. A significant correlation between the dielectric properties and freshness of four vegetables was observed. It is possible to evaluate the quality of vegetables nondestructively by determination of dielectric properties.

Branca, *et al.* (2001) reported that Italy is considered the country of origin and diversification of cauliflower where are still grown several landraces characterised mainly by different harvesting time, curd shape and colour. The object of the research activities has been to collect, to characterise and to evaluate the Italian cauliflower germplasm of interest for its agronomic, nutraceutical and technological traits. The high variance registered between and within the several landraces widespread in our country stimulated us to study, to improve and to exploit them both for fresh and industrial purpose. In fact, the produce of these landraces show high nutraceutical value and it has been traditionally appressesed only for fresh consume. The several selected and androgenic lines set up by DOFATA and ISPORT show uniformity of the main agronomic traits and the correspondent produce could be utilised also as frozen vegetables. Transformation trials showed high industrial yields (high percentage of "useful" curds) after decoring. The analysis of the thermal pretreated curd samples by blanching pointed out a lower titratable acidity, soluble solids and dry matter than the raw ones. Loss of ascorbic acid after curd blanching is about 50%, but was observed a good retention of this vitamin during ten month of frozen storage. The unpretreated curds show low ascorbil acid content sensory evaluation showed the high quality of frozen pigmented cauliflower.

Amalou, *et al.* (2007) observed that the competitiveness of agricultural products quality and the food products whose origins are vegetables, whether they are fresh or transformed depends closely on their quality. In this context, the tomato is the typical example of a product whose consumption in fresh form and/or in the form of transformed products is most appreciated by the populations of the Mediterranean basin. To evaluate the quality of this kind of product, we have measured their natural antioxidants, mainly the lycopene in fruits of some varieties of tomatoes which are cultivated in the central area of Algeria and in the various makes of tomato paste (concentrate) marketed in Algeria. The results showed that the content in lycopene was higher in the tomato paste, which was approximately 20-60 mg/100 g of dry material against 1-2 mg/100 g of tomato fresh fruits. The content in beta -carotene was lower than that of lycopene, recording between 13 and 48 mg/100 g of dry material of tomato concentrate and a relatively similar content in the fresh tomato fruits (approximately 2-6 mg/100 g of fresh fruits). On the other hand, the content in vitamin C was more significant in the fresh fruits, i.e. 11 to 22 mg/100 ml of juice against 2 to 5 mg/100 g of vitamin C in the tomato concentrate. Our results confirm, on one hand, the predominance of lycopene in the fruits and in the products containing tomato; and on the other hand, that the treatments of the transformation exert favourable effects on the lycopene content and the effects are slightly destroying the vitamin C. Such studies aim to better master the cultural conditions and to optimize well the transformation parameters.

Valle-M-del *et al.* (2007) reported that the tomato (Lycopersicon esculentum Mill.) is one of the most widely cultivated vegetable crops in Mediterranean countries. Important amounts of tomato are consumed in the form of processed products such as tomato juice, paste, puree, ketchup, and salsa. Tomato processing by-product is constituted by peel and seeds, and represent around the 4% of fruit weight. If the waste remaining is not used, it will increase the disposal problem and also aggravate environmental pollution. Besides the disposal on the field, at this moment, tomato by-product is mainly used for animal feeding, with no economical benefits for the industry. Tomato by-products have an excellent chemical composition. According to the authors, fiber is the major compound of tomato by-product 59.03%, other values are 25.73% total sugars, 19.27% protein, 7.55% pectin, 5.85% total fat and 3.92% mineral content. Moreover, tomato by-products obtained as a residue of tomato processing plants can be used to extract different compounds of high nutritional and economical values as fiber, antioxidants, or oil that can be used in food industry. Based on the interesting chemical composition of tomato by-products and fractions, the actual trends of recovery by-products propose their use in human nutrition as functional food. However, in order to use tomato by-product or some fractions (seeds and peels), first of all it is necessary to find and set an easy and economic method to separate and preserve these fractions obtained.

Devi, *et al.* (2007) stated that Vegetables are the best resource for overcoming micronutrient deficiencies in developing countries. Many indigenous vegetables, especially the leaf vegetables are rich sources of vitamin A, C, and minerals like iron, calcium, phosphorus sodium, potassium and many others. Kerala, located in the warm humid tropics enjoys a wide range of climate conditions suitable for growing a wide range of indigenous leaf vegetables variety, most commonly amaranth, drumstick, chekkurmanis, waterleaf, horse purslane, water convolvulus, ponnanganni greens, fenugreek, Indian pennywort, basella, agathi and pisonia. The beta carotene content of leaf vegetables varied from 1926 micro g (ponnanganni greens) to 22147 micro g (water convolvulus); vitamin C from 17 (ponnanganni greens) to 247 mg (chekkurmanis) and iron from 0.9 (water leaf) to 34.8 mg (water convolvulus) per 100 g edible portion. The antinutrient factors, oxalates and nitrates are present in traces in a few of these crops.

Sun-Lina *et al.* (2007) reported that soil contaminated with Cd, Pb, Cu, and Zn in the Zhangshi irrigation area is very hard to be remediated. Phytoextraction is considered as an efficient method to remove these toxic metals from soil. In the present study, three vegetables including sugar beet (Beta vulgaris), mustard (Brassica juncea L.), and cabbage (Brassica oleracea L. var. capitata Linn.) were used to bioaccumulate heavy metals in soil through pots experiment for 90 days; and nutrient elements were applied to stimulate the phytoextraction of metals. Results of bioconcentration factors (BCF) and translocation factors (TF) from this study showed that these plants could phytoextract heavy metals, but the accumulation and translocation of metals differed with species of plants, categories of heavy metals, and some environmental conditions (e.g. nutrients). Meanwhile, the addition of nutrient elements, such as N, P, and Fe, could affect the phytoremediation of heavy metals via promoting the normal metabolism of vegetables or changing forms of metals. Results of this study could provide some available information for in-site bioremediation of soil from Zhangshi irrigation area.

Favaro, *et al.* (2007) stated that calcium ions (Ca) play an important role in many biochemical processes, delaying senescence and controlling physiological disorders in fruits and vegetables. The objective of this experiment was to analyze the effect of increasing calcium concentrations in snap beans. Snap bean cultivar UEL 1 was sown in sand containing 80 mg L-1 of calcium supplemented with nutrient solution, plus calcium at different contents: 0, 75, 150 and 300 mg L-1. Ca was mainly recovered in the shoots, followed by roots and pods. Calcium concentrations in the pods were 130, 259, 349 and 515 mg 100 g-1 dry matter on a dry weight basis, in relation to the enhancement of calcium contents in the nutrient solution, respectively. A negative relationship between nitrogen content in the pods and calcium concentration in the nutrient solution was observed. Pods from plants grown in a solution without Ca presented necrosis in their apical region. Dieback of roots shoots and young leaves also occurred under low calcium supply. Dry matter of pods, roots and shoots, number of pods per plant, pod weight and pod length increased proportionally to calcium concentration in solution. Increasing rates of calcium improved biomass production in snap bean cultivar UEL 1.

2.1 Protein content in Vegetables

Gopin *et al.* (1993) reported that the selected vegetables are not a good source of protein. Maximum protein in vegetables was 1.57 to 5.42%. Most of the vegetables varieties contain protein from 0.4 to 0.8%. Little works has been done on amino acid content in vegetables. The chief point of interest in amino acid is their reaction with sugar, producing browning reaction, during the dehydration and concentration.

Subramanyan (1973) reported that the proteins are particularly associated with large quantities of carbohydrates and have powerful effect on the keeping quality of the fruits and vegetables. It is well known that organic bodies containing a high percentage of nitrogenous matter decay earlier than those containing lesser percentage protein content of fruits and vegetables on the figure obtained from different investigations comes to about 0.51 percent, which is too low indeed to cause any adverse effect during storage.

2.2 Fat content in vegetables

Little amount of fat was found in the selected vegetables. The majority of the varieties having only 0.5 to 0.9% and reported that the total lipid content of vegetables increased during ripening (Gopalan, 1976, Selvariaj 1989).

CHAPTER III

METHODS AND MATERIALS

This chapter deals with the materials and methods that were used in execution of the experiment.

3.1 Identification

The vegetables were identified with local and scientific names.

3.2 Collection of samples

Vegetables as fresh as possible were purchased from local markets in Dhaka city. Vegetables were collected during the months of September-October 2009. The vegetables selected for the study were Lalshak, Datashak, Mulashak, Karola, Potal, Potato, Country bean, Carrot, Tomato (Green), Tomato (Ripe), Cauliflower, Cabbage, Radish, Amrul leaf and Bothua. They were prioritized, because of their great popularity amongst the people of Bangladesh.

3.3 Preparation of Sample

Immediately after procurement from the market, vegetables were washed with distilled water and the surface water was drained out. Weight of the vegetables was recorded as purchased. They were then processed in usual practice. The unnecessary portion were removed and separated. Vegetables were then filleted from both sides. The processed vegetables were then washed with de-ionized water. The whole processed vegetable was then dissected and each portion was de-boned as completely as possible and the edible portion for each region was separated and minced in a mechanical grinder. Two gram samples in duplicate from each portion were taken for the determination of moisture. Rest of minced sample was collected as completely as possible, wet weight was recorded and the sample was dried in an oven at 105°C. The weights of dry samples were recorded.

The dry samples were then ground in a mechanical grinder. Nutrient analysis was accomplished in dry samples and the values were later readjusted for wet weight.

3.4.1. Estimation of minerals (Fe and Ca)

Minerals such as Fe and Ca were determined by Atomic Absorption Spectrophotometer (AA-6800) after appropriate digestion of samples.

3.4.2 Preparation of reagent for mineral analysis

- Reagent grade concentrated nitric acid (HNO_3), 70%.
- Sigma chemical company, USA for calibration curve.
- 0.4% Lanthanum solution: Atomic absorption grade lanthanum oxide (2.375 g) was transferred to a 250 mL beaker containing de-ionized water (150 mL) followed by addition of 12.5 mL HCl. The beaker was then heated and stirred till the salt dissolved. The mixture was cooled and filtered into a 500 mL volumetric flask. The volume was made up to 500 mL with de-ionized water.
- Hydroquinone solution: Hydroquinone (0.5 g) was dissolved in de-ionized water. One drop of concentrated sulphuric acid was added to retard oxidation, and the volume was made up to 100 mL with de-ionized water.
- Sodium sulphite solution: Sodium sulfite (200 g) was dissolved in de-ionized water and was diluted to 1000 mL and filtered.
- Ammonium molybdate solution: Ammonium molybdate (25 g) was dissolved in deionized water and the volume was made 300 mL. Concentrated sulphuric acid (75 mL) was diluted to 200 mL de-ionized water and was then added to ammonium molybdate solution.
- 2% HNO_3 solution: Nitric acid (20 mL) was added into de-ionized water and the volume was up to 1000 mL.
- 2 M nitric acid solution.

Procedure

About 500 mg of the dry sample was placed into 25 mL conical flask, 6 mL HNO_3 acid was added and kept at room temperature for overnight to predigest the sample. Then sample with HNO_3 acid into a digestion block port was heated at 150°C for 60 minutes to remove red fume, then cooled at room temperature. 2 mL of $HClO_4$ acid was added to the sample and placed again into a digestion block port at a block temperature of 215° for 2 hours. Then the sample was cooled in a hood for 20 minutes and 10 mL de-ionized water was added on hot plate (90°C). The solution was then mixed up well using a vortex stirred, cooled, and diluted to 50 mL volumetric flask. The solution was filtered to remove all particulate matter in the digest prior to analysis.

Calculation of mineral contents:

$$\text{Calculation: mg/100g} = \frac{\text{Total concentration} \times \text{dilution factor}}{10 \times \text{sample weight} \times \text{dry factor (D.F)}}$$

Where, Drying factor = Fresh wt. / Dry wt.

3.5.1. Preparation of standard curve for iron (Fe)

Stock-I: It was supplied from Sigma chemicals co. Ltd. The concentration of Iron was 999±2ppm.

Stock-II: An aliquot of 1 ml from Stock-I was taken in a volumetric flask and the volume was made 100 ml with de-ionized water i.e. the concentration was 10ppm.

Working standard:

Aliquot of 0.25 mL, 0.5 mL, 1.0 mL, 2.0 mL, 4.0 mL, 8.0 mL from Stock-II were taken in six volume metric flasks. The volume was made 100mL with de-ionized water. The concentrations of Iron were 0.025, 0.05, 0.1, 0.2, 0.4 and 0.8ppm respectively. A blank was prepared simultaneously with the standard of calibration curve. Absorbance was taken at 248.3 nm. The computerized Atomic Absorption Spectrophotometer was programmed to give the concentration of Iron from diluted solution of the sample.

3.5.2. Preparation of standard curve for Calcium (Ca)

Stock-I: It was supplied from Sigma chemicals co. Ltd. The concentration of calcium was 999±2ppm.

Stock-II: An aliquot of 1 ml from Stock-I was taken in a volumetric flask and the volume was made 100 ml with de-ionized water i.e. the concentration was 10ppm.

Working standard:

Aliquot of 3.3 mL, 6.7 mL, 12.5 mL, 25 mL, 50 mL, 100 mL from Stock-II were taken in six volume metric flasks. The volume was made 100mL with de-ionized water. The concentrations of Calcium were 0.33, 0.67, 1.25, 2.5, 5 and 10ppm respectively. A blank was prepared simultaneously with the standard of calibration curve. Absorbance was taken at 422.7 nm. The computerized Atomic Absorption Spectrophotometer was programmed to give the concentration of Calcium from diluted solution of the sample.

3.6 Estimation of protein

Principle:

The nitrogen present in the sample is converted to ammonium sulphate by digestion at 380°c with sulphuric acid in presence of a catalyst, potassium sulphate and mercuric oxide. Ammonia liberated by distilling the digest with NaOH solution is absorbed by boric acid and is titrated for quantitative estimation (AOAC, 1984).

Equipments: Balance, Microkjeldahl Digestion set, Microkjeldahl distillation set.

Reagents: Digestion mixture: 190 g anhydrous potassium sulphate and 4 g mercuric oxide mixed thoroughly.

60% NaOH solution: 600 g sodium hydroxide and 50 g sodium thiophosphate is dissolved in distilled water, cooled and made up the volume up to 1 L.

Boric acid: 40 g of boric acid is dissolved in water and the volume made up to 1 L.

Double indicator: 200 mg of each of methyl bromide and bromocressol green was weighed separately than both were mixed in 100 ml of 70% ethanol.

HCI solution: 8.5 ml of concentrated HCI was added to 5 L of distilled water, standardized to 0.2 N_2 acids by titrating against standard Boric acid (0.02N) solution

Procedure:

About 200 mg of finely ground sample was taken in a microkjeldahl digestion flask. To this, 500-600 mg of digestion mixture was added. 5ml of concentrated sulphuric acid was added with it and the sample was allowed to stand for about 1 hour in a microkjeldahl digestion set for digestion. The clear digest was allowed to cool and then the digest was dissolved in minimum amount of distilled water and carefully transferred to a microkjeldahl distillation set. 20ml of NaOH solution was added and it was distilled. The distillate was collected for 35 minutes into 20ml boric acid containing 2 drops of mixed indicator in a 50ml conical flask, till the color of the solution changes. The distillate was titrated against a standard HC1 solution and the titrated volume (TV) was noted.

Calculation:

Crude protein content of the sample on the percentage basis was calculated by using the following formula:

$$\text{Percentage of nitrogen} = \frac{(C-b)\times p\times 0.014\times d}{\text{Wt. of the sample}} \times 100$$

Where, c = reading of the sample, b = blank reading, p = strength of the HC1 solution d = a factor (6.25 for vegetables), Nitrogen percentage was converted into protein by multiplying with a factor 6.25.

3.7 Estimation of fat

Principle:

Fat content of food samples can be conveniently determined by extracting the dry ground material with anhydrous ether or mixture of chloroform and methanol (2:1). (Choudhury and Juliano, 1980)

Equipments: Round joint flask, shaker, balance, heater, and oven.

Procedure:

5.0 gm of dried powdered sample was taken in a round joint flask, mixed with chloroform: methanol (2:1) and shaken properly in a shaker. Then it was subjected to overnight incubation at room temperature and filtrated until the color became clear (color of the substance on the filter paper became colorless. This sample is taken for fiber estimation. Then filtrate was taken in a conical flask of known weight with boiling cheap and the flask was heated until the solvent is evaporated. Then it was dried in an oven at 105°c for 3-4 hours. Final weight of the conical flask was then taken.

Calculation:

$$\text{Percentage of fat} = \frac{\text{Final wt. of flask - Initial wt of flask}}{\text{Sample wt.}} \times 100$$

3.8 Statistical analysis

The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT) using the statistical computer package program, MSTAT (Russell, 1986), Statistical analysis was accomplished by using SPSS (SPSS/PC+ Version 12.0: SPSS Inc., Chicago).

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results obtained from the present experiment to asses the fifteen vegetables crops on their quality characters. The data have been presented in Tables for better understanding. The results of each parameter studied in the experiment have been discussed and possible interpretation was made under the following headings.

4.1 Protein content in vegetables

Protein content of different vegetables species was differed significantly. The protein content ranges from 0.81-3.73% (Table 1). Among the vegetables, the highest protein content was recorded in Bothua (3.73%) which was statistically significant different to Datashak (2.36%). The lowest protein content was recorded in Carrot (0.81%) followed by Tomato (0.98%). The second highest protein content was observed in Country Bean (2.62%). These results were in agreement with the result of Gopin *et al.* (1993) who stated that protein content in vegetables differed significantly.

4.2 Fat content in vegetables

There was a significant variation among the vegetables in respect to fat content of edible parts. All of the analyzed vegetables were poor source of crude fat. The fat content was the highest in Country Bean (0.77%) followed by Potato (0.64%). The third highest fat content was recorded in Bothua (0.42%). The lower fat content was observed in Karola and Potal with being the lowest in Karola (0.070%). Vegetable species to species variability in fat content was also observed by many workers (Lakshiminarayna, 1970; Holman *et al.,* 1982; Huss, 1988; Clucas and Ward, 1996). The differential response of fat content in different vegetables could be attributed to its genetic potentiality.

Table 1. Variation in quality characters of different species in vegetables

Vegetables	Protein (%)	Fat (%)	Carbohydrate (%)	Calcium (mg/100 g)	Iron (mg/100 g)
Potato	1.92 cde	0.64 b	23.0 a	11.10 g	0.71 f
Country bean	2.62 bc	0.77 a	6.90 de	216.0 a	1.70 de
Carrot	0.81 f	0.22 ef	13.0 c	27.30 ef	2.22 c
Tomato (green)	0.98 ef	0.11 h	3.64 gh	21.10 f	1.82 d
Tomato (ripe)	0.86 f	0.21 f	3.64 gh	50.00 cd	0.46 g
Cauliflower	2.02 bcd	0.12 gh	7.60 d	42.20 d	1.60 e
Cabbage	1.28 def	0.22 f	5.00 fg	33.10 e	0.88 f
Radish	1.05 ef	0.10 h	5.45 ef	10.20 g	0.50 g
Amrul leaf	2.91 ab	0.35 cd	15.0 b	55.00 c	3.90 b
Bothua	3.73 a	0.42 c	3.00 h	150.0 b	4.33 a
Lalshak	2.39 bc	0.19 fg	---	----	---
Data shak	2.36 bc	0.30 de	----	----	----
Mula shak	1.82 cde	0.25 ef	-----	----	---
Karola	1.1 def	0.070 h	----	----	----
Potal	1.31def	0.073 h	---	----	----
F-test	**	**	**	**	**
SE (±)	0.83	0.07	0.015	0.56	0.66

In a column, figure (s) with same letter dot not differ significantly at $P \leq 0.05$; ** Significant at 1% level of probability.

4.3 Carbohydrate content in vegetables

There was a significantly high difference in carbohydrate content among the vegetables studied ranged 3.0-23.0% (Table 1). Results revealed that most of the vegetables had less than 10% carbohydrate (range 3.0-7.60%). The three vegetables (potato, carrot and amrul leaf) had greater than 10% carbohydrate (range 13.0-23.0%). The highest carbohydrate was recorded in potato (23.0%) which was significantly different from the others. The second and third highest carbohydrate content was recorded in amrul leaf and carrot, respectively. The lower carbohydrate content was recorded in green and ripe tomato and bothua; bothua (3.0%) being the lowest. This result was in agreement with the result of Subramanyan (1973) who observed that leaf vegetables had lower carbohydrate than flower and root vegetables. There is no calculated value of carbohydrate in five vegetables like Lalshak, Data Shak, Mulashak, Karola and Potal.

4.4 Calcium content in vegetables

Calcium content among the vegetables varied significantly. The calcium content ranges from 10.20-216 mg/100 g (Table 1). The highest calcium content was recorded in country bean (216 mg/100 g) which was highly significant different to others. However, calcium content in country bean was 1.5 times higher than the second highest calcium content vegetable of bothua. The second highest calcium content was recorded in bothua (150 mg/100 g). The third and fourth highest calcium contend was observed in amrul leaf (55 mg/100 g) and ripe tomato (50 mg/100 g), respectively. Three vegetables Carrot, cauliflower and cabbage also contained considerable amount of calcium ranged from 27.3 to 42.2 mg/100 g. In contrast, the lower calcium content was recorded in potato and radish with being the lowest in radish 10.20 mg/100g (figure 4). These results were in agreement with the result of Gardner *et al.* (1939) who stated that calcium content in vegetables differed significantly. There is no calculated value of calcium in five vegetables like Lalshak, Data Shak, Mulashak, Karola and Potal.

4.5 Iron content in vegetables

There was a significant variation among the vegetables in respect of iron content. Results revealed that iron content was greater in leafy vegetables than root vegetables except carrot (Table 1). The highest iron content was found in bothua (4.33 mg/100 g) followed by amrul leaf (3.90 mg/100 g). The third highest iron content was recorded in carrot (2.22 mg/100 g). The ripe tomato and radish maintained the lower amount of iron with being the lowest in ripe tomato (0.46 mg/100 g). Vegetable species to species variability in iron content was also observed by many workers Guha and Chakawarty (1933) differential response of iron content in different vegetables could be attributed to its genetic potentiality. There is no calculated value of iron in five vegetables like Lalshak, Data Shak, Mulashak, Karola and Potal.

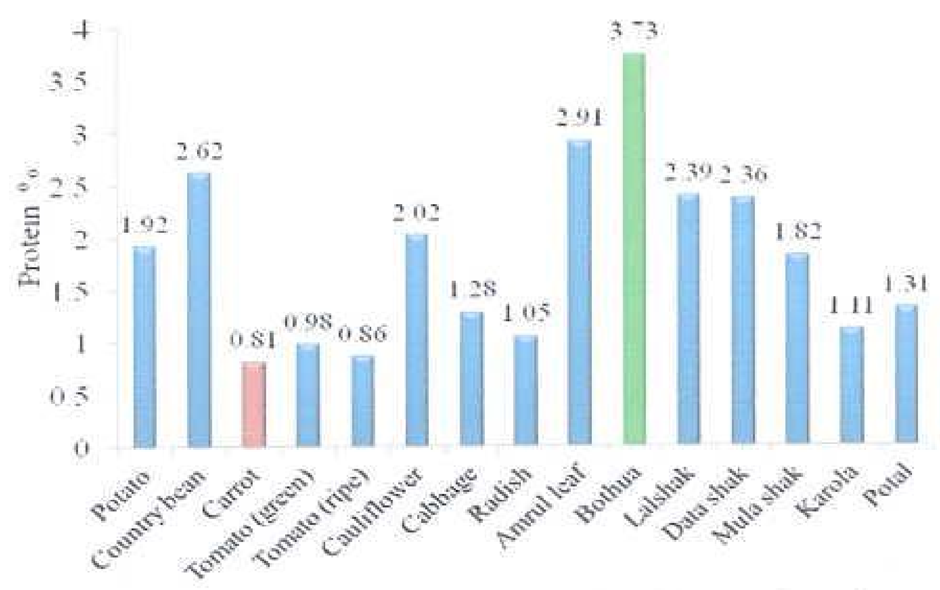

Fig: Showing protein percentage in different selected vegetables

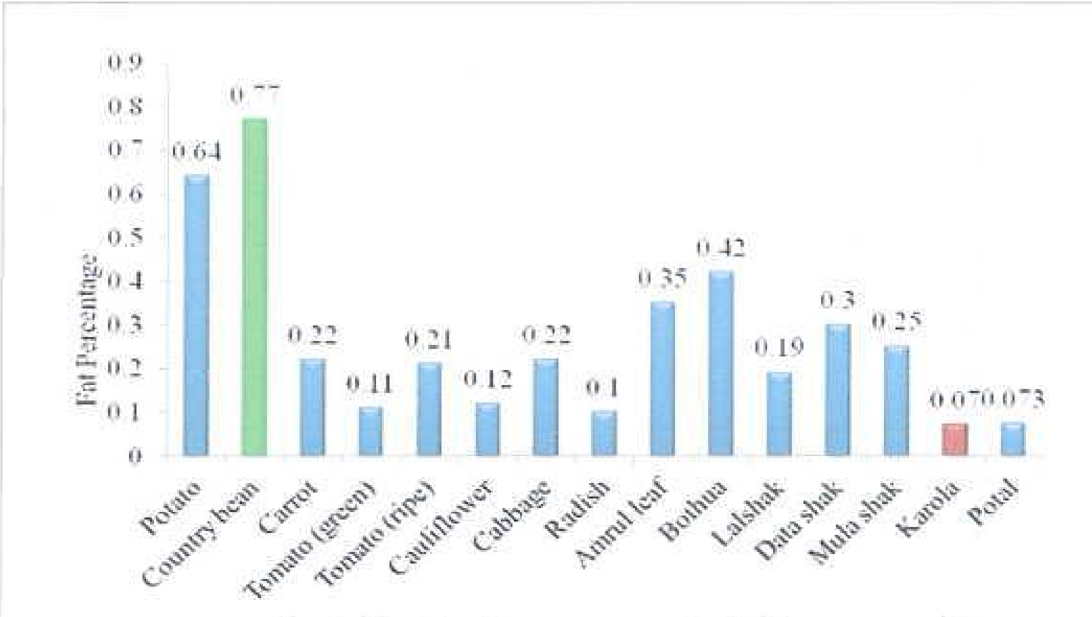

Fig: 2 Showing fat percentage in different vegetables

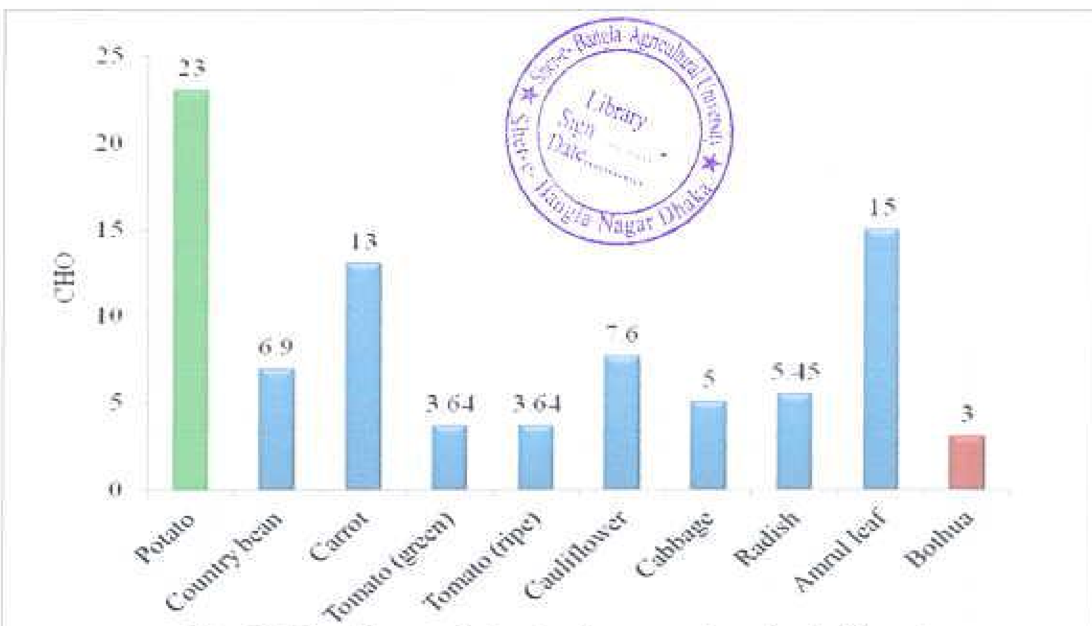

Fig: 3 Showing carbohydrate percentage in defferent vegetables

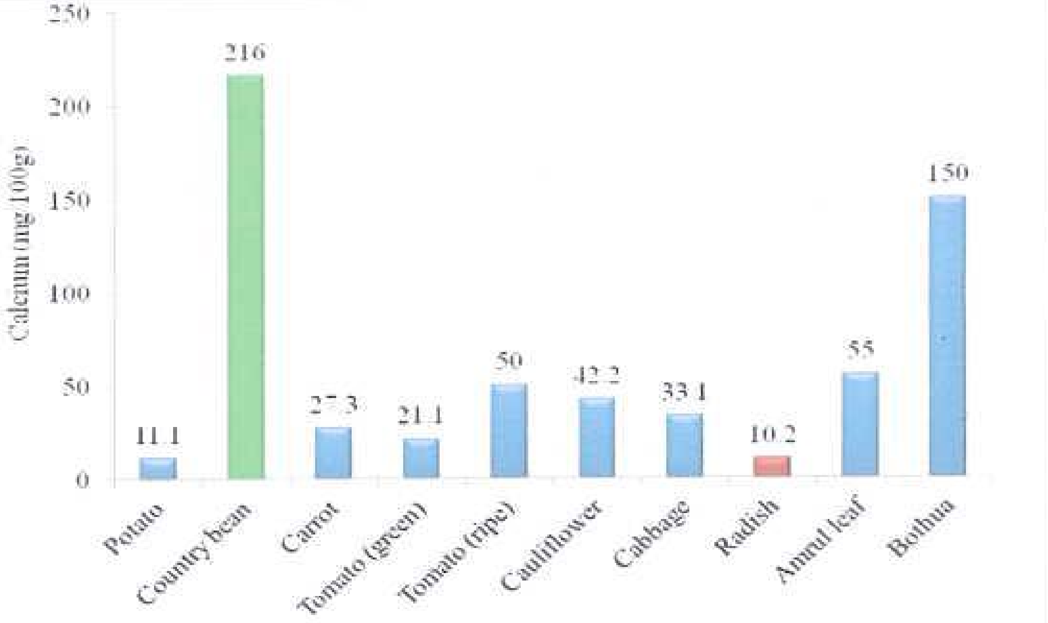

Fig: 4 Showing calcium (mg/100 g) in different vegetables

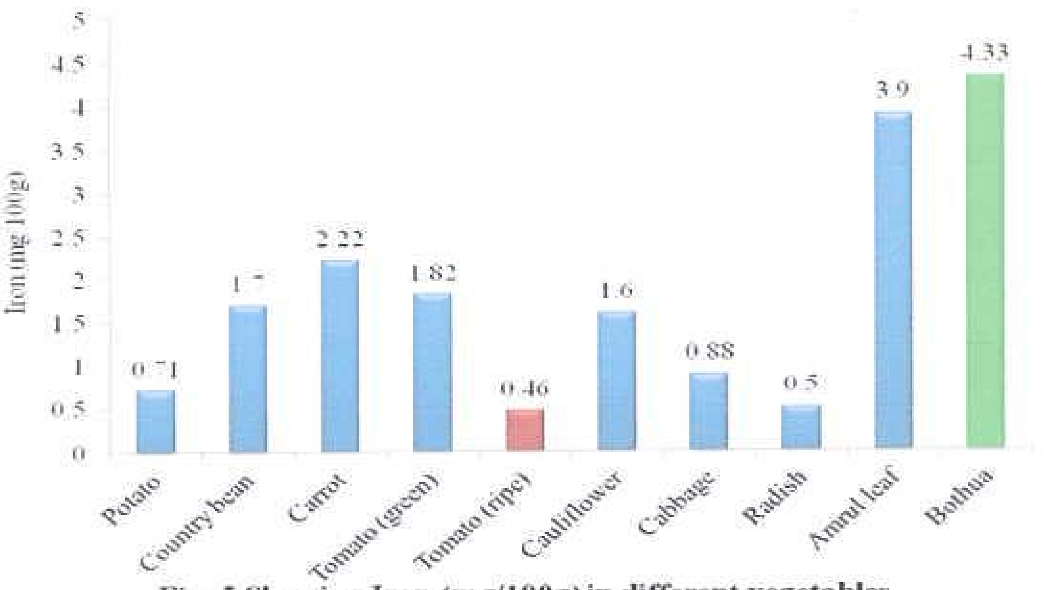

Fig: 5 Showing Iron (mg/100g) in different vegetables

Man needs a wide range of nutrients to perform various functions in the body and to lead a healthy life. The nutrients include protein, fat, carbohydrate, vitamins and minerals. These nutrients are chemical substances which are present in the food we eat daily. The chemical composition of food is of most importance including nutrition and health, toxicology and safety and stability to microbiological, chemical or physical changes. Analysis of these food components is required to provide nutrition labeling for informing the health conscious consumer.

The present study depicts the content of protein, fat, carbohydrate and essential minerals in some selected local vegetables of Bangladesh. Vegetables contribute a major share of human foods in our traditional Bangladeshi diet. Vegetables are a fair access to the essential nutrients, in which our habitual diet is grossly deficient.

Protein content of vegetables largely depends on genotypes, soil, fertilizer used, atmosphere, season etc. Several studies reported protein content of vegetables from 0.81 to 3.73 %(Bakshi and Bajwa, 1959; Banu *et al.*, 1985; Banu *et al.*, 1991; MoA, 2002). Among the vegetables, the highest protein content was recorded in Bothua (3.73%) which was statistically non-significant different to Datashak (2.36%). The lowest protein content was recorded in Carrot (0.81%) followed by Tomato (0.98%). The third highest protein content was observed in Country Bean (2.62%).

There was a significant variation among the vegetables in respect to fat content of edible parts. All of the analyzed vegetables were poor source of crude fat. The fat content was the highest in Country Bean (0.77%) followed by Carrot (0.22%). The third highest fat content was recorded in Bothua (0.42%). The lower fat content was observed in Karola and Potal with being the lowest in Karola (0.070%).

It is important to be noted that different species of vegetables differ in their content of the same nutrient. Several factors may be held responsible for this variation. Amongst several possible factors, genetic variability, seasonal variation and food staff as well as geographical location may be responsible for this difference. It has been revealed in the present study that all species of vegetables are not equally good as sources of all nutrients. Some vegetables are relatively rich and some are relatively poor in a particular nutrient. Amongst all the vegetables under present study some vegetables stand out as good sources of nutrients. Thus, dietary evaluation of vegetables should be done on all of the vegetables. So the findings of present study can play an important role to help identify good vegetables sources for fat, protein and essential minerals in our diet. It will be of immense help in updating the 'Food Composition Table' in Bangladesh. Just for the lack of necessary information about mineral content of Bangladeshi food, estimates for the intake of essential minerals could not be made in several dietary surveys conducted previously in Bangladesh. Present finding may, hopefully, ameliorate the situation at least partially.

Carbohydrate is very essential elements for our body. It provides energy to carry on the work of the body and to maintain body temperature. It spares protein. This mean when adequate carbohydrate is present, body need not burn dietary protein or body protein for energy. There was a high difference in carbohydrate content among the studied vegetables ranged 3.0-23.0% (Table 1). Results revealed that most of the vegetables had less than 10% carbohydrate (range 3.0-7.60%). The three vegetables (potato, carrot and amrul leaf) had greater than 10% carbohydrate (range 13.0-23.0%).

Calcium is one of the important sources of essential nutrients. It involves in cell division which is related to our body function. It helps in nodule formation for plant. Three vegetables; Carrot, cauliflower and cabbage also content considerable amount of calcium ranged from 27.3 to 42.2 mg/100 g. In contrast, the lower calcium content was recorded in potato and radish with being the lowest in radish

10.2 mg/100g. Calcium functions as catalysts in many biological reactions. The heartbeat is controlled by an electrical center called the "A-V" node; calcium is also involved in transmission of impulses in this center (Passwater and Cranteon, 1983). Calcium is important metabolically for the activity of certain enzymes, notably adenosine tri-phosphate in the release of energy for muscular contraction and for the activity of cyclic-AMP.

Iron plays an important role in cellular metabolism as an active component of various enzymes. In respect of iron there was a significant variation among the vegetables. The highest iron content was found in bothua (4.33 mg/100 g) followed by amrul leaf (3.90 mg/100 g). The third highest iron content was recorded in carrot (2.22 mg/100 g). The ripe tomato and radish maintained the lower amount of iron with being the lowest in ripe tomato (0.46 mg/100 g). The essential functions of iron are oxygen transport and oxygen utilization through hemoglobin and meoglobin. Iron is an essential part of enzymes and immune substances needed to destroy invading infectious organisms.

The 'Food Composition Table' in Bangladesh lacks information especially about the content of minerals in our common foodstuffs. Thus the present findings will act positively towards the enrichment of our 'Food Composition Table' in respect of mineral, protein and fat values.

CHAPTER V
SUMMARY AND CONCLUSION

The present study was considered to investigate the nutritional quality of leafy and fruit vegetables grown in Bangladesh. The experiment was done on vegetables *viz.* Lalshak, Datashak, Mulashak, Karola, Potal, Potato, Country bean, Carrot, Tomato (Green), Tomato (Ripe), Cauliflower, Cabbage, Radish, Amrul leaf, Bothua. The experiment was laid out in a single factor completely randomized design with three replications. The vegetables were collected from local markets of Dhaka city. Observations were made on nutritional quality characters of moisture, protein, carbohydrate, calcium, iron and fat. The collected data were analyzed statistically.

There was significant variation among the vegetables in respect of all quality characters such as protein, fat, carbohydrate, calcium and iron. Results revealed that protein and fat content was greater in leafy vegetables than fruit vegetables. The highest protein content was recorded in Bothua (3.73%) followed by country bean (2.62%) with same statistical rank. This country bean also contained higher amount of fat (0.77%). The second highest position in protein content was recorded in country bean (2.62%). The lowest protein content was (0.81%) with lowest amount of fat (0.070%).

Among the vegetables analyzed in the present study, some vegetables stand out as good sources for protein and fat. Lal, Data and Mulashak stand out to be good sources for protein and fat. Therefore, when measures are taken to improve food and nutrition security, there should be a focus on the production and consumption of Lalshak, Datashak and Mulashak.

Results revealed that protein content was greater in leafy vegetables than root and fruit vegetables. The highest protein content was recorded in bothua (3.73%)

followed by amrul leaves (2.91%). The lowest protein content was observed in carrot (0.81%) with lower amount of fat and carbohydrate. Country bean contained higher amount of protein (2.62%) with highest fat (0.77%) and lower carbohydrate (6.90%). In contrast, radish contained lower amount of protein (1.05%), fat (0.10%) and carbohydrate (5.45%). Potato contained the highest amount of carbohydrate (23.0%) with moderate amount of fat (0.64%) and protein (1.92%).

The highest calcium content was recorded in country bean (216 mg/100 g) which was highly and significantly different from that of others. The second highest calcium content was recorded in bothua (150 mg/100 g). In contrast, the lower calcium content was recorded in potato and radish (10.2 mg/100 g); it was the lowest in radish.

Results revealed that iron content was greater in leafy vegetables than root vegetables except carrot. The iron content was the highest in bothua (4.33 mg/100 g) followed by amrul leaf (3.90 mg/100 g). The third highest iron content was recorded in carrot (2.22 mg/100 g). The ripe tomato and radish maintained the lower amount of iron; in ripe tomato (0.46 mg/100 g) containing the lowest.

Among the vegetables analyzed in present study, some vegetables stand out as good sources for protein, fat and carbohydrate. Country bean, carrot, amrul and bothua stand out to be a good source for calcium, iron. Therefore, when measures are taken to improve food and nutrition security, there should be a focus on the production and consumption of country bean, carrot, amrul and bothua. This not only will improve the diet quality, but will also contribute positively in addressing the problem of micronutrient malnutrition of our country.

These vegetables are rich in nutritional point of view especially mineral content. Detail knowledge of mineral content of these vegetables is important to evaluate their nutritional quality because these vegetables are of plant sources in the diet of our people. About 63% of protein and essential trace minerals come from the vegetables (Chowdhury, 2001). From recent epidemiological, clinical and nutritional studies on animal and human, it is accepted that, the mineral containing enzymes of vegetables act in human body as free radical scavenger and their various role in blood and fluid circulation are helpful for preventing aging, certain forms of cancers, osteoporosis in old age and cardiovascular diseases, As vegetables' fat contain high amount of unsaturated fatty acids (Kinsella, 1988; Morris and Culkin, 1989),thereby from the analysis of mineral composition of these vegetables should be treated as a nutritious and health beneficiary food sources.

The "Food composition Table" in Bangladesh does not have sufficient information regarding the content of essential nutrients in our local foodstuff. So, the findings of present study are expected to add positively towards the enrichment our present "Food Composition Table", which will certainly lead to a better assessment for the nutrients intake of our people through habitual diet.

REFERENCES

Ahmad, K. and Hassan, N. 1992. The Nutrition survey of Rural Bangladesh, 1981-1982 1st ed. University of Dhaka, Bangladesh. Institute of Nutrition and Food Science. P. 4-5.

Ahmad, K., Huda, and Nath, P.C. 1983. Nutrition Survey of Rural Bangladesh. Institute of Nutrition and Food Science, University of Dhaka. Bangladesh. P. 27-29.

AIS (Agriculture Information Service). 2011. Krishi Diary. P. 2.

Alvarez, M.D., Fernandez,C., Canet,W. 2005. Effect of freezing/thawing conditions and long-term frozen storage on the quality of mashed potatoes. Journal of the science of food and agriculture. 2005 Nov., vol. 85, no. 14 p. 2327-2340.

Amalou, D., Ammouche, A. 2007. Evaluation of tomato fruits quality and the products derived from tomato produced and marketed in Algeria by the content measure in natural antioxidants. Acta-Horticulturae. (758). Pp: 191-198.

Amin, I., Lee,W.Y. 2005. Effect of different blanching times on antioxidant properties in selected cruciferous vegetables. Journal of the science of food and agriculture. 2005 Oct., vol. 85, no. 13 p. 2314-2320.

Anderson, L., Dible, M.V., Turkki, P.R. Mitchell, H.S. and Rynbergen, H.J. 1982. Nutritition in Health and Disease. 17th edn. J. B. Lipincott and Company, Philadelphia, U.S.A. Pp: 89-98.

AOAC, 1984. Association of Official Analytic Chemist, 14th edition, William's.

Bakshi, L. and Bajwa, M. E. 1959. Food Control and Nutritional Consequences of Biodiversity. Irrigation Support Project for Asia and the Near East. Draft. Bangladesh Flood Action Plan.Pp. 24-35.

Banu. C.P. Sultana, S. and Quazi, S. 1991. Studies on the minerals content of vegetables. Bangladesh. J. Zool Vol. 19(l):59-63.

Banu. C.P., Nahar, B, Begum, M. and Ahmad, K. 1985. Studies on the protein, riboflavin and iron content of some vegetables and a prawn of Bangladesh. Bangladesh. J. Zool. 13(1): 25-28.

Basu, S. K. 1947. India: vegetable utilization and conservation. In Jhonson 1947b. Op. cit., pp. 13-35.

Branca, F. Reddy,N.S., Geeta Bhatt. 2001. Characteristics and new costitutions of pigmented cauliflower. Italus-Hortus. 14(2). Pp: 13-24.

Chaney-Ross and Finley, J.W. 1986. Nutrition, 7th edition. Page-1, 2, 428-433.

Charmley, E., Nelson, D., Zvomuya, F. 2007. Nutrient cycling in the vegetable processing industry: utilization of potato by-products. Canadian-Journal-of-Soil-Science. 2006; 86(4): 621-629.

Chowdhury, B. H. 2001. Reduction of plasma lipids and lipoproteins in hyperlipidemic patients by dietary Omega-3. Fatty acids (abstr). Clin. Res. 29:628-632.

Cohen, N. 1989. Vitamin A deficiency Effects and Determinants of Risk. In Vitamin A deficiency in Bangladesh: Prevention and control. (Damaton). 1. (Ed.). Helen Keller International, Bangladesh Moni Printing & Package Ltd. P: 64-75.

Deshio Khaddo Drobber Pustiman. 1992. Institute of Nutrition and Food Science. Dhaka University, Bangladesh.

Devi, N.S., Kumar,P.G.S., Peter,K.V., Indira,V. 2007. Indigenous leaf vegetables for administering vitamin A and minerals. Acta-Horticulturae. 2007; (752): 367-372.

DOA (Department of Agriculture, Government of the People's Republic of Bangladesh), 2002. vegetables Resource Information of Bangladesh, pp: 44-48.

Dutta, D.C. 1986. Physical changes during pregnancy. In: Text book of Obsterics. 2nd edn. New Central Agency, Mahalaya, Calcutta. P-48.

Ernst, N.D. 1985. NIH Consensus development conference on lowering blood cholesterol to prevent heart disease: Implications for dieticians. J. Am. Diet Assoc. 85-586-588.

Favaro, S.P., Braga Neto, J.A., Takahashi, H.W., Miglioranza, E., Ida,E.I. 2007.Rates of calcium, yield and quality of snap bean. Scientia-Agricola.Pp: 616-620.

Gardner, D.M., Compbell, P.E.; Stevens, B.J.; Mayne, V.; Cart-wright, E. 1939. Menkes' kinky hair syndrome; an inherited defect in calcium absorption with widespread effects. Pediatries 50:188-207.

Georg, B. and Bongstrom J. 1962. Nutrition, Sanitation and Utilization. In vegetables as Food. Vol-2.

Gopalan, C. 1976. A manual of Laboratory techniques. National Institute of Nutrition. Indian Council of Medical Research, Hyderabad, India.

Gopin, K. L., Porter, K. H. and James, N. I. 1993. A manual of Laboratory techniqueas. Journal of Agricultural and Food Chemistry. Pp: 217: 333-361.

Granda, C., Moreira,R.G., Castell Perez,E. 2005. Effect of raw potato composition on acrylamide formation in potato chips. Journal of food science. p. E519-E525.

Grundy, S.M.., Bilheimer, D., Blackburn, H. 1982. Rationale of the diet/heart statement of the American Heart Association, Circulation 65:839-854.

Guha, N.T. and Chakawarty, R. 1933. An evaluation of the Phytate, Calcium, Iron and Manganese contents and Zinc availability from soua-based textured-vegetable protein. Brit. J. Nutr. 41: 579-589.

Guo-ShuHua, D., Nagata, M., Vuong-TienDung. 2007. Cloning and expression of tomato fruit specific promoter E8p1. Journal-of-Agricultural-Biotechnology. Pp: 362-364.

Harding, J. A. 1954. Vegetables, fatty acid and human health. New Eng. J. Med. 312: 1253.

Hassanpanah, D and Benam,-M-B-K. 2007. Effects of different water regimes on potato cultivars in Ardebil Region. Acta-Horticulturae. Pp: 313-318.

Helen Keller International and Institute of Health Nutrition, Bangladesh. Helen Keller International, New York.

Holman, R.T. Johnson, S.B. and Hatch, T.F. 1982. Human linolenic acid deficiency, Am. J. Clin, Nutr. 35: 617-622.

Huss .1988. Fresh vegetables-quality and quality changes. Food and Agriculture Organization of the United Nations Danish International development Agency, Rome.

Islam, A. 1983. A Report on Aquatic Culture. Bangladesh Agricultural Resources Survey System, 1(2), P-28.

Jenkino, S., H.C., Van Gent and C. M. Marley. 1975. The effects of various intakes of omega-3 fatty acids on the blood lipid composition in healthy human subject. Am. J. Clin. Nutr. 34: 1752.

Jhone, A., Baerthl, J.M., Gramham, G.G. 1976. Calcium deficiency in infancy. Padiatries 34:324-326.

Kalia, P., Pathania,N.K. 2007. Genetic variability and trait relationships for quantitative and quality characters in winter bean (Vicia faba L.). Acta-Horticulturae.2007. (752): 405-409.

Kinsella, L., 1988. Fats and Oils. In: Frank E. ed. Encyclopaedia of marine Resources. Van Nostrand Reinhold Co. N.Y.

Koubala, W.R. and Mbome, J. 2003. Fatty acid composition of New Zealand Shellfish Lipids. N.Z.J. Sci. 12: 207-209.

Lakshiminarayna, J. 1970. Lipid and fatty acids of important vegetables: New data for nutrient tables. J. Am. Oil Chem. Soc. 52:154-159.

Leley, B. J., Mike, S.S and Muslemuddin, M. 1989. Cholesterol content in various muscles and organs of vegetables. Dhaka. Univ. Stud. (Part-E). 4(1): 47-53.

Marufa, R. 1998. Mineral content in vegetables of Bangladesh. Institute of Nutrition and Food Science. Dhaka University.

Miller, R.G. 1956. Fatty acid composition of fish oils. In: Barlow, S.M.

Ministry of Health and Family Planning, 1992. Bangladesh Country Paper International Conference on Nutrition, Rome. Government of the Peoples Republic of Bangladesh Pp. 32-37.

MoA (Ministry of Agriculture, Government of the People's Republic of Bangladesh), 2002. vegetables Resource Information of Bangladesh, pp: 44-48.

Moniruzzaman, M. 2000. Investigation diseases of some small indigenous fresh vegetables of Bangladesh. M.S thesis, BAU, Mymensingh.

Morgan, F. 1966. Metabolism and Nutrition. In: Neonatal Medicine. Eds. Cockburn, F., Drillien, CM. Oxford and Blackwell Scientific Publications. PP: 260-303.

Morris, C. H. and Culkin R. T. 1989. Normal and therapeutic Nutrition. Indian Edition 1977 published pursuant to an agreement with the original American Publisher, Macmillan Publishing Co. Inc. NY. U.S.A.

Mukerjee. J. 1960. Observations on populations in Greenland and Denmark. In: Barlow. S.M. and and Stansby, M. E., Eds. Nutritional Evaluation of Long-Chain fatty acids in vegetable oil. Academic Press. N.Y. P. 64-67.

Murry, J and Burt, J.R. 1992. The Composition of vegetables. Ministry of Agriculture, Torry Research Station. P. 321-333.

Nettleton, A. 1985. Nutritients and Substances in Fresh Sea Food. In: Sea Food Nutrition Facts. Issues and Marketing of Nutrition of vegetables,Van Nostrand Reinhold, New York. Pp: 30-64.

Neuringer, M and Conner 1984. Dietary Omega-3 fatty acid deficiency and visual loss in infant rhesus monkeys. J. Clin. Invest. 73: 272-276.

Nilson. K. 1976. The value offish and shellfish. Food Research, 30: 177-180.

Oliv, E., Grantrom, E. and Anggard, E. 1983. The prostaglandins and essential fatty acids. In: Pace-Asciak, C. and E, Granstrom, Eds. Prostaglandins and Related Substances. Elsevier, Amsterdam.

Passwater, R. and Cranteon, E.M. 1983. Trace elements, Hair analysis and Nutrition. Keats publishing Inc. 27 Pine Street, New Cannan, C.T. U.S.A.

Pitkin, R.M. 1975. Calcium Metabolism in Pregnancy: American J. Obst. And Gyne, 121: 724-728.

Porter. M. D. 1980. LSRO, Federation of American societies for experimental Biology.

Propaneet, M., Briggs,G and Doris Howes Calloway. 1958. Nutrition and physical fitness, 10th ed. Saunders College publishing Co. Philadelphia.pp.9.

Rahman, M. L and. Ali, M. H. 1986. A study on the Credit and Marketing Aspects of vegetables in Bangladesh. Bureau of Socio-economic Research and Training, Bangladesh Agricultural University, Mymensingh, pp. 1-3.

Rezar, k., Asao,T., Taniguchi, K. 2007. Calystegines in potatoes with genetically engineered carbohydrate metabolism. Journal-of-Experimental-Botany. 2007; 58(7): 1603-1615.

Rousseaux,M. C., Jones,C. M., Adams, D. 2005. QTL analysis of fruit antioxidants in tomato using Lycopersicon pennellii introgression lines. Theoretical and applied genetics. P. 1396-1408.

Rubbi, S. F., Rahma, M. M. and Jahan, A. K. 1987. Studies on the proximate composition and quality of some commercial species of Fresh vegetables Bangladesh J. Sci. Res. 5(1), 1987: 1-20.

Sajitha,J. P., Haripriya, K., Mahesweri, T. U., Stella, D. 2007. Impact of organic nutrients on yield and quality of garden bean. Acta-Horticulturae. 2007; (752): 485-487.

Salamatullah, Q. Chowdhury, I. H. Mohiduzzaman, M. and Nahar, B. 1988. Vitamin A and Carotene Contents of vegetables. Bangladesh. J. Nutr 1(2). 27-28.

Salvias, S. H. Jr. L. Y. Roony and Harris, W. S. 1989. Polyunsaturated fatty acids, hyperlipidermia, ad thrombosis. Arteriosclerosis 2:87-89.

Selvariaj, N. W. 1989. Element of food technology. The Avi. Pub. Co. Inc. Pp-384.

Shashirekha, G. K., and Paatwardhan, W. 1976. Copper In: Trace elements in human and animal nutrition. 5th ed. Edited be Mertz, W. Academic press. New York. PP.301-364.

Srivastava, C. B. L. 1985. A textbook of Agricultural science and India, Kitab Mohal, Allahabad, India, Pp. 47-86.

Stanley, J. M. Less and Davidson G. H. 1957. A simple method for isolation and purification of total lipids from animal tissue. J. Biol. Chem.. 26: 497-502.

Stansby, M. E. Ed. 1978. Nutritional Evaluation of Long-Chain Fatty Acids in Fish Oil. Academic Press. N.Y.

Stansby, R. G. 1954. Iron deficiency in infections and immune function: a reassessment: American J. Clin. Nutri. 31: 66-70.

Subramanian, S. L., Zimmerman, D. R. and Woods, M. 1971. The Doctor's Anti Breast Cancer Diet. Simon and Schuster, NY.

Sun-Lina, Niu-ZhiXin, Sun-TieHeng. 2007. Effects of amendments of N, P, Fe on phytoextraction of Cd, Pb, Cu, and Zn in soil of Zhangshi by mustard, cabbage, and sugar beet. Environmental-Toxicology. 22(6) Pp: 565-571.

Thorup-Kristensen, K. 2006. Root growth and nitrogen uptake of carrot, early cabbage, onion and lettuce following a range of green manures. : Soil use and management. Oxford, UK,Blackwell Science Ltd. P. 29-38.

Titus, B. G., Kulmacz, R. J. and Lands W. E. M. 1982. Selective destruction and removal of heme from protagladin H Syntase. Arch. Biochem. Biophys. 214: 824-830.

USDA, Mohammad Yunus. 2003. In: Food Processes and Analyses, Bangladesh Agricultural Research Council.

Valle, M.del., Garrett, D. A., Failla, M. L., Sarama, R. J. 2007. The nutritional and functional potential of tomato by-products. Acta-Horticulturae. 2007; (758): 165-172.

Wen Qin, Ye-JinSong, Xue-WenTong, Huang-AiXixng, Hugura,Y., Suzuki,K. 2007. Correlation between dielectric properties and freshness of leaf vegetables. Journal-of-Food-Processing-and-Preservation. Pp: 736-750.

Whedon, G. D., Karnkowski, W., Abanowski, G. 1982.Calcium Nutrition and bone health in the elderly .Amer. J. Clinical Nutrition , 1982, Vol-36, p-986.

Winton, J. T., Lennpn, J. L. and Peden, V. H. 1935. Calcium dificiency in long-term parental nutrition. J.Pediater. 80: 32-36.

Yunus, M. 1997. In Food Processes and Analyses, Bangladesh Agricultural Research Council. USDA.

Yusuf, H. K. M., Salamatullah, Q. Islam N. M., Hoque I. Baquer. M. and pandav, C. S. 1993. Report of the National Iodine Deficency Disorders Survey in Bangladesh, University of Dhaka, December.

Zafri, A. and Ahmad, K. 1981. Studies on the Vitamin-A content of fresh vegetables: Content & distribution of Vitamin-A in vegetables, Bangladesh J. Bio. Sci. 10: 39-41.

Zdravkovic, J., Markovic, Z., Zdravkovic, M., Damjanovic, M. 2007. Relation of mineral nutrition and content of lycopene and beta -carotene in tomato (Lycopersicon esculentum Mill.) fruits. Acta-Horticulturae. Pp: 177-181.