BCSIR

Available online at www.banglajol.info

Bangladesh J. Sci. Ind. Res. **46(1)**, 1-8, 2011

BANGLADESH JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

E-mail: bjsir07@gmail.com

Vitamin B and Essential Minerals Contents of Mixed Solid State Fermented Millet (*Steria italic*) and Bengal Gram by *Rhizopus oligosporus*

N. Sultana[a], M. Z. Azam[b], M. Z. Amin[c], B. Shams[d], M. A. Satter[e*] and S. M. Masum[f]

[a]Department of Biochemistry, Dhaka Medical College, Dhaka, [b]Department of Biochemistry, Sir Salimullah Medical college, Dhaka, [c]Department of Nutrition and Food Technology, Jessore Science and Technology University, Jessore, [d]Department of Natural Science, Stamford University, Dhaka, [e]Institute of Food Science & Technology, BCSIR, Dhaka, [f]Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Dhaka-1000, Bangladesh.

Abstract

Mixed solid state fermentation by *Rhizopus oligosporus* on nutritional and anti-nutritional factors of dehulled cereal *Seteria italica* (millet or kaon) and legume *Cicer arietinum* (Bengal gram or chola or chick pea) were studied. The fermentation method used was similar to the traditional fermentation procedures used in the preparation of tempeh from Soybean in the orient. The duration of fermentation was 24 hours at 37^{o}C under controlled laboratory conditions. In this study, the vitamin B content especially thiamine, niacin and vitamin B6 (Pyridoxine) were estimated after 24 hours of fermentation of (50:50), (60:40) and 75:25) ratios of mixed *Seteria italica* (millet or kaon) and *Cicer arietinum* (Bangal gram or chola or chick pea) respectively. After 24 hours fermentation, thiamine content increased significantly, when compared with the thiamine content of raw state. The content of thiamine, niacin and vitamin B6 in the fermented form were also increased when compared these with soaked and steamed state respectively. Incase of minerals after fermentation iron, copper, calcium, sodium and potassium contents were decreased when compared these with raw state. The contents of iron, copper calcium, sodium and potassium in the fermented form were also decreased when compared with the iron, copper, calcium, sodium and potassium contents of soaked and steam state respectively. The nutritional factors like B vitamins (thiamine, niacin, and vitamin B6) were increased significantly however, minerals were decreased. Our results suggest that tempeh can be prepared with millet and Bengal gram may be a good source of vitamin B6 for children and aged people.

Keywords: *Rhizopus oligosporus,* Tenpeh, Bengal gram, Vitamin B, Essential minerals

Introduction

Bangladesh is a developing country, where malnutrition is a serious problem. It is more severe among the rural population especially the women and children are the worst victims (Islam and Fatimi.1993). Malnutrition begins in the mother's womb and affects fetal development and productivity. Malnutrition after birth continues to decrease resistance to disease and itself is a root of disease.

Malnourished population is less productive not only because of their lack of intelligence but also due to their frequent illness. Among these people economic growth is likely to be slower. Not only inventiveness, initiative and imagination may be wanting, but also because the labor force may be weaker, they may be more languid and more prone to diseases (News and notes,1980).

Some possible cause of this problem are poverty, large family size, food habit, more expenditure of food, poor hygienic condition, lack of nutrition education, improper food allocation for children and mothers (pregnant and lactating) have great influence on dietary intake and nutritional status. Inadequate diet intake, loss of nutrients due to the family milling, high percentage of breakage and loss during washing and cooking elevate the malnutrition (Sarwar, 1992; Zakaria and Puspriatin,1986).

The problem of malnutrition so long could not be prevented by existing food supplies and improper distribution of food to meet the need of people. Unfortunately, this was not been possible because of technical, economic, political and religious reasons (Marcus *et al.* 1975).

* Corresponding author: E-mail: mabdussatter@yahoo.com

Since the present nutritional status of Bangladesh is not satisfactory, the need of boosting up the nutritious food production is must in Bangladesh. Nutrition-oriented agriculture and food processing (in choosing certain agricultural commodities and processing them into acceptable foods) are important in combating malnutrition. The choice of commodity becomes more significant if it is nutritionally, economically and religiously acceptable (Zakaria and Puspriatin,1986).

But in the end, the problem of malnutrition is every one's problem. When the strong political commitment in the government is there, when a strong health infrastructure exist in the country and have many national vertical program directed towards the components of social up liftmen and primary health care and only a perception of the magnitude of the problem of malnutrition and an accountable and extensible inter agency cooperation seems essential in tackling malnutrition as national priority (Ialam and Fatimi, 1993).

The diet of Bangladesh people is based on cereals and legumes that serve the sources of energy and protein. Legumes (pulses) are the cheapest source of protein and considered to be the Poor's meat. Availability of protein from animal source is already scarce because fish production has down than requirement to decimate use of fertilizer and pesticide. So, to meet the requirement of protein from plant source it is a need fen rich Bangladesh (Aykoroyd and Joyce, 1964; Gowda and Kaul, 1982).

Cereals constitute by far the most important group of foodstuffs. They are treated as staple food of a large majority of the population through out the world. They provide about 70 to 80 percent of calories, protein, fat and other nutrient of the low income group.

Legumes commonly called pulses have been considered poor man's meat, since they provide a comparatively cheaper source of protein which is valuable for the low income strata of the society and who cannot afford animal protein. Grain legumes (pulses) supplements effectively cereals to improve in their overall nutrition, since essential amino acid lysine, which is generally deficient in cereals but have adequate amounts of sulpher-containing amino acids. On the other hand, the proteins of legume grains are rich source of lysine and low of methionine (sulpher containing). It is therefore, often comphasized that legume-grain proteins are the natural supplement of cereal grain proteins (Gowda and Kaul, 1982).

Most cereals grains are poor in minerals content. Rice is an especially poor source of calcium and iron. However, millet, ragi, bajra are also good sources of these mineral.

The legumes are considerably richer in calcium than most other cereals. A representative value for the group as a whole is about 100 mg/100g (Aykoroyd and Joyce, 1964).

Seteria italica (millet or kaon) and Cicer arietinum (Bengal gram or chola or chick pea) are important sources of B-vitamins and minerals. So proper food processing could meet up this malnutrition problem especially in the poor people. Therefore in this study, we havefocused on the proper processing of the cereal and legume.

By traditional solid state fermentation process of cereal and legume "tempeh" is prepared. Tempeh is a popular delicious and nutritious food in Indonesia. "Tempeh" produced pleasant aroma with alcoholic smell which increases its acceptability and is becoming popular food in USA, Japan, China, Taiwan and India. Due to fermentation, protein availability and digestibility improves, so also B vitamins along with anti nutrient factors present in legumes (Milner and Whiteside, 1981).

There are many legumes and cereals, among them Bengal gram and millet are available. *Seteria italic*a (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chick pea) are important sources of carbohydrates, proteins, B vitamins and minerals (Aykoroyd and Joyce, 1964; Gowda and Kaul, 1982). The purpose of this study was to increase the availability of B-vitamin in these seeds by solid state fermentation .Through this process even weaning food (with or without milk or sugar) for the growing children, old people and other vulnerable group may also be fed.

Materials and Methods

Millet and Bengal gram seeds procured from the local market were used for this study. Dehusked millet and "dal" were cleaned and kept at room temperature until test was done. In a 100 ml beaker 50g of seeds were soaked in water (1:3 seeds to water ratio) overnight(12h), washed and steamed for 10 min and dried at room temperature to remove excess water. Steamed seeds were inoculated with 0.5% inoculums of *Rhizopus oligosporus* a mold collected from the Nutrition Research Centre, Bogor, Indonesia.

For the preparation of inoculums by growing tempeh mold on rice or steamed cassava flours. The mold culture was then dried in the sun to when the spores had fully matured. It was then ground to powder. Inoculums made by growing tempeh mold on rice has shelf like of six months at 25^o C when stored in a closed container (0.5% mean desire amount of inoculums). One portion of the soaked and steamed seeds was kept in the refrigerator (kept at 4^oC) as control. Inoculated seeds were packed in glass petrideshes and fermented in an incubator at 37^oC for 24h. After fermentation they were kept in a refrigerator as fermented sample. For the raw sample it also control dried and cleaned seeds were ground in a mechanical grinder and stored at room temperature. So we obtained three kinds of sample-

1. Inoculated seeds.
2. Soaked and steamed seeds (Controls).
3. Raw sample-(dried and cleaned).

For the study purpose, we mixed these three types of seeds each in three ratios like (millet 50: Bengal gram 50), (millet 60: Bengal gram 40), (millet 75: Bengal gram 25).

B-vitamin both for unfermented and fermented seeds were determined by standard methods (Jami-Osamani, 1953; Dean, 1958).

Thiamine was determined according to Lyman *et al.* (1952). Niacin was analyzed calorimetrically according to the method of AOAC. Vitamin B6 was estimated microbiologically using Saccharomyces Carlsbergensis (ATCC9080) as assay organism according to Hyderabad manual method (Jami-Osamani, 1953) .

Minerals were estimated by Atomic Absorbance Spectrophotometer as described by Milner and Whiteside, 1981.

Statistical analysis

After coding and editing, the collected data were analyzed by using SPSS software package. The results were presented as the means ± SD, of at least three separate experiments. Statistical significance was determined by students t-test. A value of $p \leq 0.05$ was considered to be significant.

Results

The effect of fermentation on vitamins content of *Seteria italica* and *Cicer arietinum mixed* seeds are shown in Table I. After fermentation, thiamine contents by *Seteria italica, Cicer arietinum* were increased to20.58%, 19.44% and 21.05% when compared with the thiamine content of raw state, respectively. Thiamine contents were also increased to 64.0%,79.16% and 53.35% respectively when compared with the thiamine content of soaked and steamed state. Niacin contents were increased to 30.43%, 27.19% and 33.47% respectively when compared with the Niacin content of raw state. Niacin content were also increased to 42.11%, 48.72% and 45.00% respectively when compared with the Niacin content of soaked and steamed state. Vitamin B6 contents were increased to 37.68%, 35.84% and 23.80% respectively when compared with the vitamin B6 content of raw state. Vitamin B6 content were also increased 69.64%, 63.64% and 67.72 respectively when compared with the vitamin B6 content of soaked and steamed state.

The iron content of unfermented raw, control and fermented *(24h) Seteria italica* (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chickpea) mixed seeds are represented and compared in the Table II. The iron content of unfermented control and 24h fermented *Seteria italica* and *Cicer arietinum* mixed seeds[*Seteria italica* (millet or kaon) 50: *Cicer arietinum* (Bengal gram or chola or chick pea 50], [*Seteria italica* (millet or kaon) 60: *Cicer arietinum* (Bengal gram or chola or chick pea) 40] and [*Seteria italica* (millet or kaon) 75: *Cicer arietinum* (Bengal gram or chola or chick pea) 25] were found to be 9.00,8.90,8.75 and 7.94, 7.89, 7.83 mg/100g respectively (Table II). Compared to unfermented control mixed seeds iron content was found to be decreased 11.77, 11.34 and 10.51% (Table II).By performing t-test p=0.05 which found significant.

Zinc content of unfermented control mixed seeds and 24h fermented *Seteria italica* (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chick pea) mixed seeds[*Seteria italica* (millet or kaon) 50: *Cicer arietinum* (Bengal gram or chola or chick pea 50],[*Seteria italica* (millet or kaon) 60: *Cicer arietinum* (Bengal gram or chola or chick pea) 40] and [*Seteria italica* (millet or kaon) 75: *Cicer arietinum* (Bengal gram or chola or chick pea) 25] were found to be 0.79,0.65, 0.51 and 0.68, 0.57, 0.45 mg/100g respectively (Table II). Compared to unfermented control mixed seeds, zinc content decreased 13.92, 12.30 and 11.76% during the 24 h of fermentation. The decrease of zinc content may be washing of *Seteria italica* and *Cicer artinum* seeds. The t-test performed that p=0.05 which found significant.

Table I: Effect of fermentation on Vitamin Content of Seteria Italica and Cicer arietinum Mixed Seeds

Vitamins	Steria Italica/ Cicer arietinum	Vitamin Content (mg/100g)			% of Effect	p-value
		Raw	Soaked and Steamed (Control)	After fermentation (24h) fermented		
Thiamine	50:50	0.34±0.029	0.25±0.016	0.41±0.22	20.58(+ve)** 64.0(+ve)	significance p≤0.05
	60:40	0.36±0.030	0.24±0.029	0.43±0.022	19.44(+ve)** 79.16(+ve)**	significance p≤0.05
	75:25	0.38±0.023	0.30±0.016	0.46±0.029	21.05(+ve)* 53.33(+ve)*	significance p≤0.05
Niacin	50:50	2.07±)0.029	1.90±0.022	2.70±0.037	30.43(+ve)* 42.11(+ve)*	significance p≤0.05
	60:40	2.28±0.036	1.95±0.041	2.90±0.041	27.19(+ve)* 48.72(+ve)	significance p≤0.05
	75:25	2.48±0.033	2.00±0.044	3.31±0.051	33.47(+ve)* 45.00(ve)*	significance p≤0.05
Pyridoxine	50:50	0.69±0.057	0.56±0.036	0.95±0.029	37.08(+ve)* 69.64(+ve)	significance p≤0.05
	60:40	0.53±0.036	0.44±0.045	0.72±0.050	35.84(+ve) 63.64(+ve)	significance p≤0.05
	75:25	0.42±0.029	0.31±0.036	0.52±0.044	23.80(+ve) 67.72(+ve)	significance p≤0.05

This table compares the vitamins contents of Steria/Cicer arietinum before and after fermentation.
Values are expressed as mean ±SD of three samples, each analyzed in triplicate (on dry weight basis)
*(+Ve) - Increased
*(-Ve)- Decreased

Copper content of unfermented control and fermented (24h) *Seteria italica* (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chickpea) mixed seeds are represented and compared in the Table II. Copper content of unfermented control mixed seeds and fermented mixed seeds[*Seteria italica* (millet or kaon) 50: *Cicer arietinum* (Bengal gram or chola or chick pea 50], [*Seteria italica* (millet or kaon) 60: *Cicer arietinum* (Bengal gram or chola or chick pea) 40] and [*Seteria italica* (millet or kaon) 75: *Cicer arietinum* (Bengal gram or chola or chick pea) 25] were found to be 0.84,0.76, 0.67 and 0.72, 0.65, 0.56 mg/100g respectively (Table IV). Compared to unfermented control mixed seeds copper content decreased 14.28, 14.47 and 16.41% during 24 h of fermentation periods (Table II).By performing t-test p=0.05 which found significant.

The calcium content of unfermented raw, control and fermented *Seteria italica* (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chickpea) mixed seeds are represented and compared in the Table- II. Calcium content of unfermented mixed seeds(control) and 24h fermented *Seteria italica* (millet or kaon) and *Cicer arietinum* (Bengal gram or chick pea) mixed seeds [*Seteria italica* (millet or kaon) 50: *Cicer arietinum* (Bengal gram or chola or chick pea 50], [*Seteria italica* (millet or kaon) 60: *Cicer arietinum* (Bengal gram or chola or chick pea) 40] and [*Seteria italica* (millet or kaon) 75: *Cicer arietinum* (Bengal gram or chola or chick pea) 25] were found to be 66.19,62.87,61.77 and 63.89, 59.45, 58.08 mg/100g respectively (Table -II). Compared to unfermented control mixed seeds calcium content decreased to 3.47, 5.43 and 5.97% during of fermentation (Table II).

The iron content of unfermented raw, control and fermented 24h *Seteria italica* (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chickpea) mixed seeds are represented

Table II. Efect of fermentation on mineral content of seteria italica and cicer arietinum mixed seeds

Vitamins	Steria Italica/ Cicer arietinum	Before fermentation Soaked and Steamed (Control)	After fermentation (24h) fermented	% of Effect	p-value
Iron Content (mg/100g)	50:50	9.00±0.11	7.94±0.071	11.77 (-ve)*	significance p≤0.05
	60:40	8.90±0.081	7.89±0.081	11.34 (-ve)*	significance p≤0.05
	75:25	8.75±).057	7.83±0.043	10.51 (-ve)	significance p≤0.05
Zinc Content mg/100g	50:50	0.79±0.029	0.68±0.022	13.92 (-ve)*	significance p≤0.05
	60:40	0.65±0.033	0.57±0.022	12.3 (-ve)*	significance p≤0.05
	75:25	0.51±0.024	0.45±0.029	11.76 (-ve)*	significance p≤0.05
Copper Content mg/100g	50:50	0.84±0.029	0.72±0.029	14.28 (-ve)*	significance P≤0.05
	60:40	0.76±0.024	0.65±0.033	14.47 (-ve)*	significance p≤0.05
	75:25	0.67±0.039	0.56±0.029	16.41 (-ve)*	significance p≤0.05
Calcium Content mg/100g	50:50	66.19±0.043	63.89±0.036	3.47 (-ve)*	significance p≤0.05
	60:40	62.87±0.049	59.45±0.054	5.43 (-ve)*	significance p≤0.05
	75:25	61.77±0.036	58.08±0.043	5.97 (-ve)*	significance p≤0.05
Sodium Content mg/100g	50:50	50.16±0.037	48.21±0.040	3.89 (-ve)*	significance p≤0.05
	60:40	48.24±0.040	46.98±0.036	3.86 (-ve)*	significance p≤0.05
	75:25	46.8±0.036	44.17±0.037	5.62 (-ve)*	significance p≤0.05
Potassium Content mg/100g	50:50	510.00±3.56	500.00±2.94	1.96 (-ve)*	significance p≤0.05
	60:40	480.00±4.55	468.00±2.16	2.66 (-ve)*	significance p≤0.05
	75:25	450.00±3.74	435.00±3.56	3.33 (-ve)*	significance p≤0.05

This table compares the minerals contents of Steria/Cicer arietinum before and after fermentation.
Values are expressed as mean ±SD of three samples, each analyzed in triplicate (on dry weight basis)
* (+Ve)- Increased * (-Ve)- Decreased

and compared in the Table II. Sodium content of unfermented control mixed seeds and 24h fermented mixed seeds [*Seteria italica* (millet or kaon) 50: *Cicer arietinum* (Bengal gram or chola or chick pea 50], [*Seteria italica* (millet or kaon) 60: *Cicer arietinum* (Bengal gram or chola or chick pea) 40] and [*Seteria italica* (millet or kaon) 75: *Cicer arietinum* (Bengal gram or chola or chick pea) 25] were found to be 50.16,48.24,46.8 and 48.21, 46.98, 44.17 mg/100g respectively (Table II). Compared to unfermented control mixed seeds sodium content decreased 3.89, 3.86 and 5.62% (Table II). Present study showed that sodium content decreased after fermentation. This finding might be considered nutritionally advantageous (p=0.05).

The potassium content of unfermented control and fermented 24h *Seteria italica* (millet or kaon) and Cicer arietinum (Bengal gram or chola or chickpea) mixed seeds are represented and compared in the Table II. Potassium content of unfermented (control) mixed seeds and 24h fermented *Seteria italic*a (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chick pea) mixed seeds[Seteria italica (millet or kaon) 50: *Cicer arietinum* (Bengal gram or chola or chick pea 50], [*Seteria italica* (millet or kaon) 60: *Cicer arietinum* (Bengal gram or chola or chick pea) 40] and [*Seteria italica* (millet or kaon) 75: *Cicer arietinum* (Bengal gram or chola or chick pea) 25] were found to be 510, 480,450 and 500, 468, 435 mg/100g respectively (Table II).

It was found that potassium content of mixed *Seteria italica* (millet or kaon) and *Cicer arietinum* (Bengal gram or chola or chick pea) seeds were decreased after fermentation. In Compared to unfermented control seeds the potassium content was decreased to 1.96, 2.66 and 3.33% (Table II). The t-test showed that p=0.05 which found significant.

Discussion

The B vitamin act as a cofactor in enzymatic reactions. They work side by side with some minerals. In this way, they could increase the utilization of those minerals. So, increased amount of B vitamins in tempeh is beneficial for the utilization of micronutrient as well as macronutrient.

Thiamine, niacin and vitamin B6 content increased during fermentation. Roelofsen and Thalens (1964) found higher levels of thiamine, riboflavin and nicotinic acid both in tempeh and soybeans than those observed by Murata *et al.* (1961). They also found that the level of riboflavin, vitamin B6, niacin and pantothenic acid in "tempeh" were much higher after fermentation. Similarly an increase of thiamine content was reported by Gandjar in tempeh gem bus using the similar mold inoculum (Gandjar *et al.* 1985; Hermana 1992 and Steinkraus *et al*. 1961), found considerable increase in niacin content of soybean after fermentation. Wang and Hesseltine (1966) verified vitamin content of tempeh through fermentation of wheat with *Rhizopus oligosporus* and found marked increased in niacin and riboflavin. Mosleuddin and Mahmud (1988); Murata *et al*. (1988); Hermana (1972), Robinson and Kao (1977), observed that tempeh mold *Rhizopus oligosporus* can synthesize large amount of vitamin B6. B6 found rich in meat (organ meat) which is costly. Whole grain cereals and peanut are also rich source (Murata *et al.* 1961). *Seteria italica* and *Cicer arietinum* are grown in Bangladesh and content of vitamin B6 is rich. Though the vitamin B6 content of the fermented *Seteria italica* and *Cicer arietnum* mixed seeds are not sufficient, the product will also be enriched with other nutrients after this process.

The B vitamins act as a cofactor in enzymatic reactions. They work side by side with some minerals. In this way they could increase the utilization of those minerals. So, increased amount of B vitamins in tempeh is beneficial for the utilization of micronutrient as well as macronutrient.

Iron is an essential element for the body. It functions as a carrier of oxygen to the tissues from the lungs, as a transport medium for electrons within cells, and as an integrated part of important enzymatic reactions in various (Bothwell *et al.* 1979; Dallman, 1986). A deficient supply of iron is very common cause of anemia. Anemia reduces work capacity of man. Chronic nutritional iron deficiency anemia may lead to a fatal result. So to meet up the iron deficiency our present study would be use full. The RDA for iron is 6 mg for infant (minimum) and 30 mg for pregnant women (Recommended, Dietary, Allowances, 1989). In this study, we found that *Seteria italica* and *Cicer arietinum* mixed temph (50:50), (60:40) and (75: 25) ratios contained about 7.94, 7.89 and 7.83 mg/100g of iron, respectively. This would partially relieve the demand of iron for infant and pregnant mother.

Another mineral Zinc is essential for the normal growth, reproduction and life expectancy of animals and as beneficial effects on the processes of tissue repair and wound healing[25].Navert[26] showed that Zinc availability and absorption was increased in soy formula by the removal of phytic acid through long-term fermentation. The RDA zinc is 5 mg/day for infants and 19 mg/day for lactating mother (Recommended, Dietary, Allowances, 1989). Our present study on *Seteria italica a*nd *Cicer arietinum* mixed tempeh can help partially to the requirement of zinc for infants and lactating mother. As copper is required for diverse functions, it also identified as a constituent of a number of enzymes. Low copper level elevates blood cholesterol. Beside this the Dietary zinc and copper ratio is important for heart disease (Dowdy, 1969). So, our present study focused on copper content after fermentation.

In this study, copper content was found to be decreased after fermentation. This results consistence with Brune et al. 1992 they reported that prolonged fermentation copper content decreased but absorption of copper available must be considered nutritional advantages (Brune, 1992).

The decrease in copper content was due to the washing of *Seteria italica* and *Cicer arietinum* seeds. Brune (1992) showed that prolonged fermentation copper content decreased but absorption of copper available must be considered nutritional advantages.

In this study, we also examined the content of calcium after fermentation, as calcium is a macro mineral and associated with bones and tooth formation (Whedon, 1982) and also has a role in the transmission of nerve impulses and it is directly related to muscle contraction (Bronner and Harris 1956).This study showed that in control seeds calcium contents decreased due to fermentation. It has been reported that Calcium releases during the 17 h fermentation (Nelson and Kirby 1987).

Sodium is a monovalent cation present in the body primarily in the extra cellular fluids. It maintains acid base balance, osmotic pressure, muscle contraction and nerve impulses, absorption and transport of glucose and other nutrient. Sodium deficiency causes general lethargy,debility. More attention has been focused on sodium and its relationship to hypertension (Guthrie, 1983; Dietary Factor and Blood pressure, 1981).

Present study showed that sodium content decreased after fermentation. This finding might be considered nutritionally advantageous.

Potassium deficiency may occur in infant suffering from diarrhea and vomiting, severe protein energy malnutrition and surgery may also lead to potassium depletion. It has been confirmed tat high potassium low sodium diet normalized blood pressure of hypertension patient (Black 1952). As potassium is very important for human being, So present study also focused on the fermentative effect on potassium. In this study, potassium contents were decreased due to the fermentation.

Since solid state fermentation is a cheap, easy and less time consuming process, so by mixed cereals and legume through solid state fermentation, we can make diet nutritionally sound for adults and through this process even weaning food for growing children may be prepared. Due to fermentation all B -vitamin content improves, we have long lasting tradition of consumption of fermented food stuff like pantabhat and dadhi, fermented foods are likely to remain an important part of the human food for many years to come. Our study suggest that tempeh can be used to improve nutritional status of poor people.

Conclusion

In this study, the tenpeh, which prepared with millet and Bengal gram could be useful to improve the nutritional status of poor people especially for children and aged people in Bangladesh.

References

Aykoroyd W.R and Joyce Doughty (1964). Legumes in Human Nutrition. *Food and Agricultural Organization of United Nations* (FAO). **37:** 40-66.

Association of Official Analytical Chemists (AOAC). (1984). Official Methods of Analysis. Williams S. Association of Official Analytical Chemists, Inc-Virginia. 14th edn., 841-842.

Advances in Pulses Research in Bangladesh: Proceeding of 2nd National Workshop on Pulses. Joydevpur, Bangladesh. 6-9 Jan 1989.

A Manual of Laboratory Techniques. National Institute of Nutrition. Indian Council of Medical Research. Jami-Osamani, Hydarabad-7.,A.P. India 1953: pp 32-34.

Black, D. *et al.* (1952). Experimental Potassium depletion in man. *Cli. Sci.,* **11**: 397.

Bothwell T. H., Charlton R. W., Cook J. D. and Finch C. A. (1979). Iron metabolism in man, Oxford Blackwell Scientific publication., pp 25-27.

Bronner F. and Harris R. S. (1956). Absorption and Metabolism of Calcium in human Beings Studied with Calcium. *Am NY Acad Sci* **64:** 314-325.

Brune M., Rossender-Hulten L., Hallberg L., Erlamdsson M, Sandberg A. S. (1992). Iron absorption from bread. Inhibiting effect of cereal fibre, phytate and inositol phosphates with different number of phosphate groups. *J. Nutr.* **122** : 442-449.

Dallman P. R. (1986). Biochemical basis for the manifestations of iron deficiency: *Annual Review of Nutrition* **6:** 13-14.

Dean R. F. A. (1958). The use of processed plant proteins as human food. In processed plant food-stuff. A.M. Altschul, editor, Academic press. New York, USA. P 205-247.

Dowdy R. P. (1969). Copper metabolism: *Am J Clin Nutr,* **22**: 887-892.

Dietary Factor and Blood pressure: (1981). Diary Council Digest **52**: 5-7.

Gandjar I., Slamet S. D. J., Sabikoen W. (1985). The thiamine content of l tempeh gembus enriched with rice polish. Paper Presented at the Seminar of the Asociation of Southest Asian Institutions of higher learning on Food Technology and Nutrition.Yog Yakanta, Indonesia.8-10.

Gowda C. L. L. and Kaul A. K. (1982). Pulses in Bangladesh: Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and Food and Agricultural Organization of The United Nations. P 429-430.

Guthrie A. (1983). Helen Introductory Nutrition: The C.V Mosby Company St. Louis Toronto London 6th ed. 118-128.

Hermana. Tempeh- (1972). An Indonesian fermented soyabean food. Nutrition Research Institute Kompleks GIZI dji Sembodja, Bogor, Indonesia. **4:** 5-7.

Islam M. Nurul and Fatimi L. E. (1993) Magnitude of the problem of malnutrition in Bangladesh and how to address the issue. *Bangladesh J Nutr: Bangladesh National Nutrition Council*. **6**(1): 29-33.

Lyman C., Ory M. R., Trant M. and Richii G. (1952) Determination of thiamine in rice and rice products. *Anal chem.* **24**: 1020-1024.

Marcus K., Owen Fennema R. and Daryl B. (1975). Lund. Principle of Food Science Part- II,Physical Principal of Food Preservation. Marcel Dekker. Inc. New york and Basel. 1-4.

Milner B. A. and Whiteside P .J. (1981). An introduction to Atomic Absorption Spectrophotometry. Pye Union Ltd. Cambridge England. pp 43-46.

Murata K., Ikehata H. and Miyamoto T. (1961). Studies on nutritional value of tempeh. Osaka City University, Osaka, *Japan. J. Food Sci.* **32**(5): 580-586.

Moslehuddin A. B. M. and Mahmud. (1988). Vitamin B6 level in the solid state fermented Lathyrus sativus seeds. *Bangladesh J. Nutr* **2**(1): 20-22.

Navert B., Sandstrom B. and Cederblad A. (1985). Reduction of the phytate content of bean by leaving in bread and its effect on absorption of zinc in man: British *J. Nutr.* **53**: 47-53.

News and notes. (1980). Workshop on Research and development need in the field of fermented foods. *Food and Nutrition Bulletin: UNU* **2**(2): 32-34.

Nelson T. S. and Kirby L. K. (1987). The Calcium binding properties of natural phytate in chick diets: *Nutrition Report Inter* **35**(5): 949-954.

Oerleas D., Muhrer M. E. and O. Dell B. L. (1966) Dietary metal complexing agents and in Salability in the rat. *J. Nutr.* **90:** 56-58.

Roelofsen P. A. and Thalens A. (1964). Changes in some B vitamins during molding of soybeans by Rhizopus oryae in the production of tempeh kedelee: *J. Food Sci*. **29**(2): 224.

Recommended, Dietary, Allowances, Food and Nutrition Board, National Research Council National Academy of Science, 10th ed. 1989 11-13.

Seinkraus K. H., Hand D. B. and Hackler L.R. (1961). Studies on temeh-An Indonesian fermented Soybean food In National Academy of Science, National Research Council Publication. **843:** 275-279.

Sarwar H. (1992). Economic implication of malnutrition in Bangladesh. *J Nutr. Bangladesh National Nutrition Council* **5**(1): 15-20.

Wng, H. L. and Hesseltine C. W. (1966). Wheat tempeh. *J. Cereal Chem*. **43**(5): 563-570.

Whedon G. D. (1982). Calcium nutrition and bone health in the elderly: *Am J Clin Nutr*, **36**: 986.

Zakaria F. and Puspriatin T. (1986). The role of tofu processing in development and the allevation of malnutrition in West Java. *Food and Nutrition Bulletin; Dec.***5**(4): 32-34.

Received : September 02, 2009;
Accepted : October 26, 2010