International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 3253-3259
© 2018 IJCS
Received: 01-07-2018
Accepted: 02-08-2018

K Abhirami
M.Sc Scholar, Department of Food Science and Nutrition, Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

L Karpagapandi
Assistant Professor (FSN), Department of Family Resource Management, Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

Correspondence
K Abhirami
M.Sc Scholar, Department of Food Science and Nutrition, Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

Nutritional evaluation and storage stability of multigrain *Nutri-chikki*

K Abhirami and L Karpagapandi

Abstract
Chikki a traditional confectionery product prepared using groundnut and jaggery is preferred by people of all age group in India. An attempt was made to enrich its nutritional quality by developing a multigrain *Nutri-chikki* with millets, pulse, oil seeds and seeds of pumpkin and flax and also assessed the nutritional and storage stability. The standardized multigrain *Nutri-chikki* was organoleptically evaluated using a sensorial affective hedonic scale. The results indicates that multigrain *Nutri-chikki* comprises of protein 14.78 g, fat 16.6 g, fiber 4.1 g and minerals like iron 9.67 mg, calcium 269.9 mg, potassium 839.75 mg, phosphorus 565.1 mg, magnesium 462.92 mg which is nutritionally superior to groundnut *chikki* and it showed acceptable sensory score of 8.3 for overall characteristics against groundnut *chikki* (7.8). The *chikkis* stored at TP_2 and TP_3 had an acceptable sensory score at the end of storage period (20 days) at room temperature.

Keywords: Traditional snack, multigrain, *Nutri-chikki*, nutritional, storage stability

1. Introduction
Nowadays people are more conscious about their health and hence they started to focus on nutritional content of the food they eat more than the taste. Hence the multigrain products becomes famous due to the presence of mixture of nutrients in it and also people in the present world have no time to find out specific foods for each nutrient and eat. Therefore, they prefer multigrain products, which provide them with their expected nutrients in a single food. All ages of population, mainly children prefer multi nutrient snack more than the multi nutrient foods. There are many traditional foods in India, which also include confectionary products that give us good and unique taste and also healthy for human beings. Among those, *Chikki* plays an important role in ready to eat traditional sweet products that is preferred by all age groups of our population. In *chikki*, there are different types based on the added ingredients such as groundnut *chikki*, sesame *chikki*, roasted bengal gram *chikki* etc. Nowadays, multigrain are included for preparing these kinds of traditional snack items for optimal health benefits. In view of this, the study aimed to prepare *Nutri-chikki* with multigrain such as pumpkin seed, flax seed, groundnut, almond, foxtail millet, black sesame seed and roasted bengal gram for providing multi nutrients.

Pumpkin seeds contribute protein significantly to the human daily-recommended protein level, which was reported to be range from 23 to 56 percent (NRC, 1980) [1]. Roasted pumpkin seeds help to relax nerves and muscles, strengthen bones and help with circulation. Roasting also reduces significantly anti-nutritional components namely tannic and phytic acids. The consumption of flax/pumpkin seed mixtures resulted in a significant decrease in lipid parameters suggesting the antiatherogenic potential of the seed mixture (Barakat and Mahmoud, 2011) [2]. Flaxseed is an alternative to marine products because of its high alpha-linolenic acid content; the use of flaxseed has been advocated to combat Cardio Vascular Diseases (Rodriguez-Leyva, 2010) [3]. Omega-3 fatty acids in flaxseed may help protect against certain infections and in treating conditions including ulcers, migraine headaches, attention deficit/hyperactivity disorder, eating disorders, preterm labor, emphysema, psoriasis, glaucoma, Lyme disease, lupus, and panic attacks (Harper *et al.*, 2006) [4]. The groundnut are a good source of vitamin E which is a dietary antioxidant that helps to protect cells from oxidative stress, and magnesium which is important for muscle function including the heart, enzyme function and energy production (Medline plus, 2016) [5].

Almonds are an excellent source of bioavailable α tocopherol, and increasing their intake enhances the resistance of low density lipid against oxidation.

In addition, the polyphenolic constituents of almonds have been characterized recently and found to possess antioxidant actions (Chen *et al.*, 2006) [6]. The foxtail and proso millet grain feeding decreased the triacylglycerol level and foxtail millet reduced C-reactive proteins which is an inflammation related indicator in hyperlipidaemic rats suggesting their potential application in lowering the risk for CVD (Lee *et al.*, 2010) [7]. Sesame seed is widely used in food and nutraceutical industries in many countries because of its high oil, protein and antioxidant contents. Sesame and its related products should be encouraged in diet as one of the circumventive measures against disorders such as hypertension, hypercholesterolemia, cancer, oxidative stress, and neurodegenerative diseases like Alzheimer's disease (Kanu *et al.*, 2010) [8]. Among the different pulses, chickpea has been reported to have a higher protein bioavailability (Yust *et al.*, 2003) [9]. Bengal gram consumption for a period of several weeks may reduce serum cholesterol level by increasing faecal excretion of total bile acid. Presence of isoflavones in bengal gram may also have hypocholesterolemic effect. Then the final ingredient is Jaggery, it is used traditionally as a sweetener in the preparation of many products. It is a potential source of minerals such as iron, calcium, magnesium, phosphorus. In the present study, the multigrain *Nutri-chikki* was developed and evaluated its nutritional quality, storage stability against groundnut *chikki*.

2. Methodology

2.1 Materials and chemicals

Grains such as pumkin seed *(Curcubita sp.)*, flax seed (*Linum usitatissium L.*), ground nut (*Arachis hypogeal L.*), almond *(Prunus dulcis)*, foxtail millet (*Setaria italic*a), sesame *(Sesamum indicum)* black and white, roasted bengal gram *(Cicer arietinum*), oats *(Avena sativa)* and sweeteners such as jaggery, corn syrup, sugar were purchased in bulk from local market of Madurai city. Packaging material viz., polyethylene bags (150-gauge thickness), metalized polypropylene pouch, and plastic round container were used for packing multigrain *Nutri-chikki*. Chemicals and reagents used in the experiments were of Laboratory Reagent (LR), Analytical Reagent (AR) or Guaranteed Reagent (GR) grade. All the reagents and standard stock solutions were prepared using purified deionized water and primary standard solutions.

2.2 Preparation and standardization of *chikki*s:

The standardization of multigrain *Nutri-chikki* was done with pumpkin seed, flax seed, groundnut, foxtail millet, oats, almond, black sesame, white sesame, roasted bengal gram, jaggery, little amount of corn syrup and evaluated its consistency through organoleptic evaluation. Based on this evaluation, the six combinations of *Nutri-chikkis* were prepared with different grains such as pumpkin seed, flax seed, ground nut, almond and foxtail millet as standard ingredients in the ratio of 20:10:20:5:20 (75 %) and variations (25 %) were made with oats, white sesame, black sesame and roasted bengal gram (Table 1 and Plate 1). The procedure for the preparation of standardized *Nutri-chikki* is given in Figure 1.

Table 1: Different combinations of the multigrain *Nutri-chikki* made for standardization

Trials	Composition	Ratio
C	Standard groundnut *chikki*	100
T1	Standard ingredients: Roasted Bengal gram : White sesame	75:20:5
T2	Standard ingredients: Roasted Bengal gram : Black sesame	75:20:5
T3	Standard ingredients: Oats: White sesame	75:20:5
T4	Standard ingredients: Oats: Black sesame	75:20:5
T5	Standard ingredients: Roasted Bengal gram: Oats : White sesame	75:10:10:5
T6	Standard ingredients: Roasted Bengal gram: Oats : Black sesame	75:10:10:5

Fig 1: Preparation of Multigrain *Nutri-chikki*

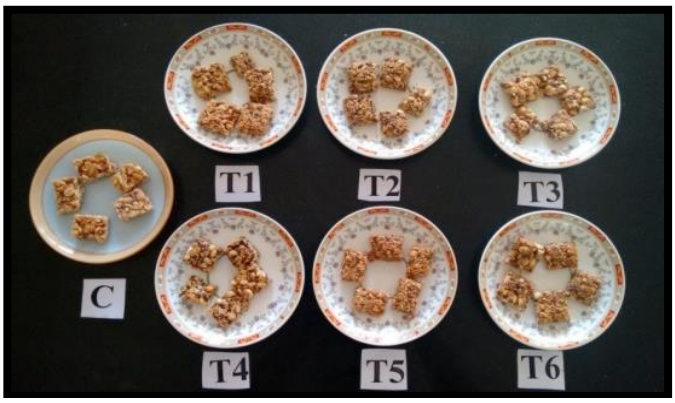

Fig 2: Multigrain *Nutri-chikki* – Six combinations with control *chikki*

C – Control
T_1 – Standard ingredients + roasted bengal gram + white sesame
T_2 – Standard ingredients + roasted bengal gram + black sesame
T_3 – Standard ingredients + oats + white sesame
T_4 – Standard ingredients + oats + black sesame
T_5 – Standard ingredients + roasted bengal gram + oats + white sesame
T_6 – Standard ingredients + roasted bengal gram + oats + black sesame

2.3 Organoleptic evaluation
The prepared six different combinations of multigrain *Nutri-chikki* were evaluated organoleptically for various quality attributes such as colour and appearance, texture, flavour, taste and overall acceptability, by a panel of 10 untrained judges using nine point hedonic scale (9-1) as per the procedure given by Watts *et al.* (1989) [10].

2.4 Chemical analysis
2.4.1 Proximate analysis
The proximate composition of multigrain *Nutri-chikki* was estimated by using standard procedures i.e., Moisture, Ash (AOAC, 1995) [11], Acidity (Ranganna, 1995) [12], Protein (Ma and Zuazaga, 1942) [13], Fat (Cohen, 1917) [14] and Fibre (Shukla, 2015) [15].

2.4.2 Free fatty acid and Peroxide value
Free fatty acid and peroxide value of the samples were estimated by the method described by Ranganna (1995) [12]. To convert % free fatty acids (as oleic) to acid value, multiply the former by 1.99.

2.4.3 Mineral analysis by AAS
One gram of samples were acid digested using triple acid (nitric, sulphuric, perchloric acids in the ratio 9:2:1) by keeping in sand bath until getting a clear solution and filtered through Whatmann No. 41 ash less filter paper. The filtrate was made up to 100 ml and the obtained triple acid extract (ash solution) was used for the estimation of iron, calcium, magnesium, phosphorus and potassium. The clear extract of prepared triple acid extracts was fed into the Atomic Absorption Spectrophotometer (AAS). The absorption of light by the atoms of the element in the vaporized sample was related to the concentration of the desired metal in it. The concentration of the desired mineral in the solution was measured by comparison with absorbance measurements on standards of known composition.

2.5 Storage stability
The standardized *Nutri-chikki* and control *chikki* were stored at room temperature (36±1°C) by packing 100 g of the each sample in polyethylene bags, metalized polypropylene pouch and plastic round containers (Plate 2) to study their storage behaviour by observing the changes in chemical composition and organoleptic characters. Analysis of multigrain *Nutri-chikki* was done initially and at 5 days of intervals up to 20 days from the packing.

Fig 3: Different packing materials used for storage study

P_1 – Polyethylene Pouch P_2 – Metallised Polypropylene Pouch P_3 – Plastic Round Container	C – Control T – Treatment

2.6 Statistical analysis
The data obtained during storage period were subjected to statistical analysis to find out the impact of storage period and packaging materials on the quality of the standardized multigrain *Nutri-chikki* during storage. Completely Randomized Design (CRD) was applied for the analysis.

3. Results and Discussion
3.1 Standardization of Multigrain *Nutri-chikki*
All the multigrain *Nutri-chikkis* prepared with six combinations of grains was organoleptically accepted with the range of scores (7.5 to 8.3). Among these, the *Nutri-chikki*

(T_2) consisting of pumpkin seed, flax seed, ground nut, almond, foxtail millet, roasted bengal gram and black sesame had the highest score (8.3) than other *chikkis* (Figure 2). The selected combination was appealed to have good taste, low cost of production and better nutritional value.

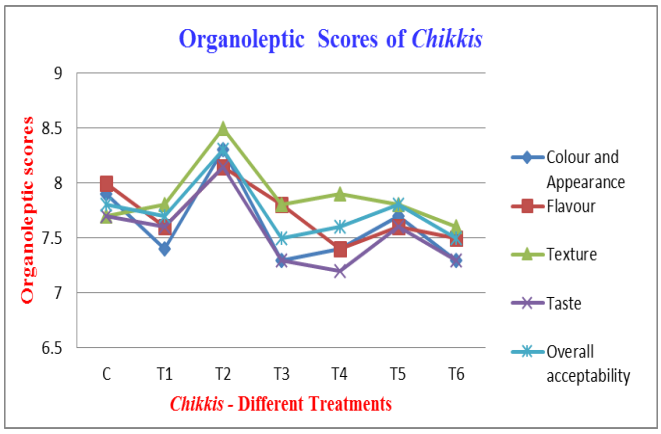

Fig 4: Organoleptic evaluation scores of prepared *chikkis* (Hedonic scale)

3.2 Chemical composition of the standardized multigrain *Nutri-chikki:*

The chemical constituents like moisture, acidity, protein, fat, crude fiber, ash, and minerals such as calcium, iron, phosphorus, potassium and magnesium content of standardized multigrain *Nutri-chikki* (T_2) and groundnut *chikki* were analysed and given in table 2. The protein content of the multigrain *Nutri-chikki* was found to be 14.78 g, which is high when compared to groundnut *chikki* (12.21 g). Other nutrients like moisture 0.15g, acidity 1.5g, fat 16.6g, fiber 4.1g and mineral contents like iron 9.67 mg, calcium 269.9 mg, potassium 839.75 mg, phosphorus 565.1 mg and magnesium 462.92 mg are present in the standardized multigrain *Nutri-chikki* (T_2). It was found that nutrient content of multigrain *Nutri-chikki* was higher than standard groundnut *chikki*. The protein content of the multigrain *Nutri-chikki* was 14.78 g which is higher than control *chikki* (12.21 g). Foxtail millet protein characterization showed that its protein concentrate is a potential functional food ingredient and the essential amino acid pattern suggests possible use as a supplementary protein source to most cereals because it is rich in lysine (Mohamed *et al*., 2009) [16].

The multigrain *nutri-chikki* contains high amount magnesium (462.9 mg) when compared to groundnut *chikki*. The need of magnesium is important to maintain normal muscle and nerve functions and a healthy immune system (Settaluri *et al*., 2012) [17]. Magnesium promotes normal blood pressure, keeps bones strong, and helps to regulate blood sugar levels. Sesame seed consumption increases plasma γ-tocopherol and enhances vitamin E activity, which is reported to prevent cancer and heart diseases (Cooney *et al*., 2001) [18]. The multigrain *Nutri-chikki* has potassium content (839.7 mg) which may be contributed by jaggery added to the *chikki*. The potassium content of the *Nutri-chikki* was higher than groundnut *chikki*. The potassium and low amount of sodium present in jaggery maintain the acid balance in the body cells, and also combat acids and acetone, and control our blood pressure. Iron helps to prevent anaemia, helps to relieve tension and takes care of asthma, as it has anti allergy properties (Jaswant Singh *et al*., 2013) [19]. This property can also be contributed by the multigrain *Nutri-chikki* because it contains iron (9.67 mg) which is more when compared to groundnut *chikki* (4.4 mg). The calcium content of multigrain *Nutri-chikki* (269.9 mg) was higher than groundnut *chikki* (147.6 mg). Calcium balance studies have determined the dietary and supplemental calcium requirements needed to optimize bone mass in healthy subjects (Munro Peacock, 2010) [20]. Similarly the phosphorus content of multigrain *Nutri-chikki* (565.1 mg) was higher than groundnut *chikki*.

Table 2: Nutritional composition of standardized multigrain *Nutri-chikki*

S No	Parameters (per 100 g)	Groundnut *Chikki*	Multigrain *Nutri-chikki*
1.	Moisture (g)	0.19 ± 0.006	0.15±0.002
2.	Ash (g)	2.2±0.052	2.8±0.053
3.	Acidity (g)	0.8±0.010	1.5±0.014
4.	Protein (g)	12.21±0.149	14.78±0.110
5.	Fat (g)	12.2±0.240	16.6±0.530
6.	Fibre (g)	2.8±0.013	4.1±0.106
7.	Iron (mg)	4.4±0.086	9.67±0.085
8.	Calcium (mg)	147.6±0.008	269.9±0.978
9.	Potassium (mg)	798.6±0.538	839.75±0.714
10.	Phosphorus (mg)	378±0.345	565.1±0.071
11.	Magnesium (mg)	225.2±0.290	462.95±0.779

Value of mean ± S.D. (n=3)

3.3 Study on storage stability

3.3.1 Changes in chemical constituents of *Chikkis* during storage

The standardized multigrain *Nutri-chikki* (T_2) and groundnut *chikki* (100 g) were packed in polyethylene bag (P_1), Metalized polypropylene pouch (P_2), Plastic round container (P_3) as shown in fig 2 and stored at room temperature. The stored *chikkis* were analysed for various chemical constituents initially and regular intervals of once in 5 days up to 20 days and given in table 3.

The moisture content and acidity of the groundnut *chikki* (C) and multigrain *Nutri-chikki* (T_2) which were found to be increasing on storage and found that multigrain *Nutri-chikki* stored in plastic round container (P_3) gained less moisture (1.36 %) and less acidic (0.32 g) than other two types of packaging (1.55 % and 0.9 in P_1 and 1.38 % and 0.5 in P_2). The fat content of the groundnut *chikki* (C) and multigrain *Nutri-chikki* (T_2) which was found to be decreasing on storage in all the packaging materials (P_1, P_2 and P_3). The estimation of free fatty acid and peroxide value was started from the 5th day of storage period because only on decomposition of the product the free fatty acid and peroxide value is produced and was found to be increasing. The product stored in polyethylene bag (P_1) was found to have more (0.4 %) free fatty acid on storage when compared to other two types of packaging (0.3% in P_2 and 0.24 in P_3). Similarly increase in peroxide value on storage was found to be more (1.29 ppm) in polyethylene bag (P_1) than other two types of packaging (0.27 in P_2 and 0.28 in P_3). The moisture content of the groundnut (C) and multigrain *Nutri-chikki* (T_2) significantly (p<0.05) increased during storage at room temperature for 20 days. Among packaging materials, polyethylene bag (P_1) and metalized polypropylene pouch (P_2) significantly (p<0.05) increased the moisture content of the multigrain *Nutri-chikki* (T_2) than plastic round container (P_3) during storage.

Table 3: Changes in chemical constituents during storage

Treatments		Storage days	Moisture (%)	Acidity (g/100g)	Fat (g/100g)	Free fatty acid (g/100g)	Peroxide value (ppm)
C	P_1	5th day	1.31±0.010^{fg}	0.90±0.006^{a}	11.50±0.088^{a}	1.22±0.033^{a}	28.22±0.432^{a}
		10th day	1.35±0.019^{f}	1.02±0.008^{a}	10.56±0.150^{a}	1.25±0.038^{a}	28.25±0.172^{a}
		15th day	1.70±0.027^{d}	1.10±0.004^{a}	10.22±0.305^{a}	1.29±0.040^{a}	28.31±0.462^{a}
		20th day	2.30±0.043^{a}	1.70±0.027^{a}	9.82±0.267^{a}	1.33±0.034^{a}	28.35±0.868^{a}
	P_2	5th day	0.63±0.012^{o}	0.85±0.018^{a}	11.86±0.379^{a}	1.20±0.011^{a}	28.20±0.115^{a}
		10th day	1.00±0.014^{l}	0.93±0.017^{a}	11.25±0.321^{a}	1.22±0.031^{a}	28.23±0.518^{a}
		15th day	1.90±0.155^{c}	0.97±0.015^{a}	11.05±0.157^{a}	1.26±0.014^{a}	28.28±0.923^{a}
		20th day	2.00±0.009^{b}	1.50±0.031^{a}	10.78±0.102^{a}	1.29±0.038^{a}	28.3±0.905^{a}
	P_3	5th day	1.10±0.024^{k}	0.80±0.012^{a}	11.92±0.081^{a}	1.18±0.00^{a}	28.25±0.538^{a}
		10th day	1.15±0.032^{jk}	0.89±0.004^{a}	11.52±0.101^{a}	1.20±0.037^{a}	28.32±0.905^{a}
		15th day	1.52±0.033^{e}	0.92±0.005^{a}	10.86±0.103^{a}	1.22±0.028^{a}	28.38±0.714^{a}
		20th day	1.90±0.025^{c}	1.25±0.017^{a}	10.44±0.348^{a}	1.25±0.034^{a}	28.42±0.502^{a}
T	P_1	5th day	0.97±0.014^{l}	1.70±0.028^{a}	15.80±0.102^{a}	1.70±0.010^{a}	34.26±0.060^{a}
		10th day	1.00±0.000^{l}	1.87±0.054^{a}	15.50±0.337^{a}	1.82±0.029^{a}	34.35±0.934^{a}
		15th day	1.27±0.012^{gh}	1.90±0.055^{a}	15.35±0.469^{a}	1.90±0.053^{a}	34.49±0.093^{a}
		20th day	1.70±0.011^{d}	2.40±0.001^{a}	15.2±0.351^{a}	2.10±0.060^{a}	35.55±0.435^{a}
	P_2	5th day	0.86±0.010^{m}	1.52±0.047^{a}	16.0±0.130^{a}	1.60±0.029^{a}	34.20±0.744^{a}
		10th day	0.80±0.023^{n}	1.65±0.004^{a}	15.7±0.138^{a}	1.68±0.021^{a}	34.31±0.677^{a}
		15th day	1.23±0.035^{hi}	1.71±0.019^{a}	15.4±0.125^{a}	1.72±0.010^{a}	34.40±0.163^{a}
		20th day	1.53±0.015^{e}	2.0±0.042^{a}	15.0±0.459^{a}	1.90±0.027^{a}	34.48±1.032^{a}
	P_3	5th day	0.77±0.014^{n}	1.5±0.014^{a}	16.0±0.511^{a}	1.55±0.008^{a}	34.23±0.535^{a}
		10th day	1.00±0.021^{l}	1.61±0.024^{a}	15.9±0.205^{a}	1.59±0.000^{a}	34.30±0.023^{a}
		15th day	1.20±0.007^{ij}	1.60±0.029^{a}	15.5±0.337^{a}	1.62±0.003^{a}	34.42±0.257^{a}
		20th day	1.51±0.025^{e}	1.82±0.043^{a}	15.26±0.321^{a}	1.79±0.042^{a}	34.51±0.352^{a}

Value of mean± S.D. (n=4)

Mean values with different superscripts in a column within the group differ significantly at $p \leq 0.05$

P_1 – Polyethylene Pouch P_2 – Metallised Polypropylene Pouch P_3 – Plastic Round Container	C – Control T – Treatment

3.3.2 Changes in sensory qualities of *Chikkis* during storage

The shelf life of groundnut *chikki* (C) and multigrain *Nutri-chikki* (T_2) in three packaging conditions were also analysed by organoleptically at regular intervals up to 20 days and the changes in flavor and texture qualities are given in figure 3 and 4. The multigrain *Nutri-chikki* (T_2) was found to have a good crunchy and brittle texture when packed in P_2 and P_3 throughout the study period (0 – 20 days). The scores in respect to all the parameters are gradually reduced. This could be due to absorption of moisture content by the *chikki*. Among the packaging, P_2 in both groundnut and multigrain *Nutri-chikki* has more overall acceptability followed by P_3 packaging material (Table 4). The sensory qualities of the groundnut (C) and multigrain *Nutri-chikki* (T_2) significantly ($p<0.05$) differ in the flavor texture and taste during storage. Among packaging materials, polyethylene bag (P_1) significantly ($p<0.05$) decreased the flavor, texture and taste of the groundnut (C) and multigrain *Nutri-chikki* (T_2) than metalized polypropylene pouch (P_2) and plastic round container (P_3) during storage.

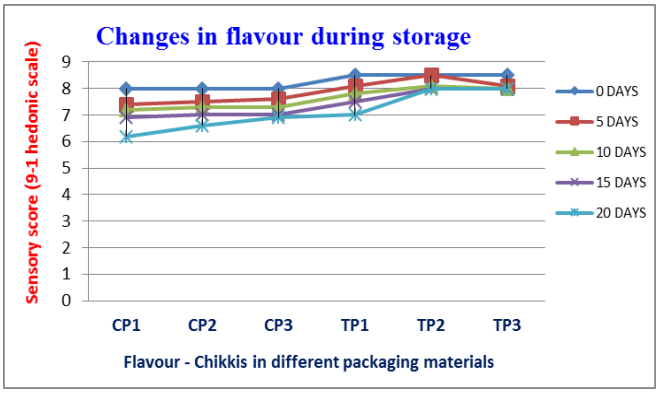

Fig 3: Changes in flavour qualities of *Chikkis* during storage

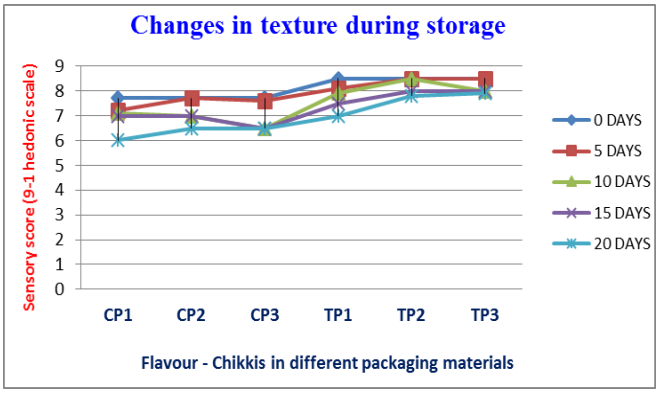

Fig 4: Changes in texture qualities of *Chikkis* during storage

Table 4: Sensory evaluation of *Nutri-Chikki* and Control *chikki* packed in different packaging materials during storage

Nutri-chikki/ Control	Days of storage	Color and appearance	Flavour	Texture	Taste	Overall acceptability
CP_I	0 day	8.4±0.163^{a}	8.0±0.084^{bc}	7.7±0.040^{def}	7.7±0.136^{efg}	8.0±0.103^{de}
	5 days	8.1±0.209^{a}	7.4±0.171^{ef}	7.2±0.093^{def}	7.6±0.010^{fg}	7.8±0.111^{efg}
	10 days	8.0±0.146^{a}	7.2±0.235^{fgh}	7.1±0.004^{h}	7.6±0.093^{fg}	7.4±0.080^{h}
	15 days	7.0±0.161^{a}	6.9±0.190^{gh}	7.0±0.076^{f}	7.0±0.147^{h}	7.0±0.114^{i}
	20 days	6.5±0.075^{a}	6.2±0.212^{jk}	6.0±0.130^{cde}	6.5±0.216^{i}	6.5±0.084^{j}
CP_2	0 day	8.4±0.217^{a}	8.0±0.108^{bc}	7.7±0.190^{g}	7.7±0.188^{defg}	8.0±0.010^{de}
	5 days	8.2±0.122^{a}	7.5±0.250^{def}	7.7±0.188^{a}	7.7±0.246^{ef}	7.8±0.122^{efg}
	10 days	8.0±0.027^{a}	7.3±0.153^{efg}	7.0±0.009^{h}	7.0±0.090^{h}	7.0±0.209^{i}
	15 days	7.5±0.025^{a}	7.0±0.133^{gh}	7.0±0.204^{g}	7.0±0.138^{h}	7.0±0.028^{i}
	20 days	7.0±0.052^{a}	6.6±0.026^{ij}	6.5±0.207^{a}	7.0±0.019^{h}	7.0±0.066^{i}
CP_3	0 day	8.4±0.084^{a}	8.0±0.023^{c}	7.7±0.222^{g}	8.0±0.014^{de}	8.0±0.084^{de}
	5 days	8.3±0.146^{a}	7.6±0.196^{de}	7.6±0.165^{g}	7.7±0.104^{efg}	7.8±0.037^{efg}
	10 days	8.0±0.228^{a}	7.3±0.163^{efg}	6.5±0.181	6.0±0.020^{j}	6.0±0.036^{k}
	15 days	7.5±0.112^{a}	7.0±0.215^{hi}	6.5±0.097^{ah}	6.0±0.126^{j}	6.0±0.073^{k}
	20 days	7.0±0.047^{a}	6.9±0.075^{k}	6.5±0.207^{a}	6.0±0.069^{j}	6.5±0.194^{j}
TP_I	0 day	8.5±0.069^{a}	8.5±0.177^{bc}	8.5±0.121^{g}	8.15±0.124^{d}	8.3±0.186^{cd}
	5 days	8.1±0.077^{a}	8.1±0.126^{bc}	8.1±0.005^{h}	7.9±0.069^{def}	7.9±0.161^{ef}
	10 days	8.0±0.217^{a}	7.8±0.148^{cd}	7.9±0.053^{a}	7.6±0.139^{dg}	7.6±0.201^{fgh}
	15 days	7.5±0.132^{a}	7.5±0.173^{def}	7.5±0.183^{a}	7.5±0.137^{fg}	7.5±0.066^{gh}
	20 days	7.0±0.100^{a}	7.0±0.023^{gh}	7.0±0.023^{bc}	7.5±0.122^{g}	7.0±0.009^{i}
TP_2	0 day	8.6±0.195^{a}	8.5±0.080^{a}	8.5±0.045^{i}	8.7±0.169^{a}	8.7±0.106^{ab}
	5 days	8.5±0.140^{a}	8.5±0.140^{ab}	8.5±0.040^{def}	8.5±0.127^{ab}	8.5±0.127^{b}
	10 days	8.0±0.195^{a}	8.1±0.033^{bc}	8.5±0.266^{b}	8.5±0.052^{bc}	8.5±0.011^{bc}
	15 days	8.0±0.114^{a}	8.0±0.195^{bc}	8.0±0.179^{a}	8.15±0.171^{bc}	8.3±0.234^{cd}
	20 days	8.0±0.163^{a}	8.0±0.212^{bc}	7.8±0.068^{b}	8.0±0.250^{d}	8.0±0.223^{cde}
TP_3	0 day	8.5±0.283^{a}	8.5±0.202^{a}	8.5±0.133^{bcd}	8.15±0.086^{cde}	8.3±0.062^{d}
	5 days	8.2±0.078^{a}	8.1±0.264^{a}	8.5±0.133^{ef}	8.1±0.137^{d}	8.0±0.081^{cde}
	10 days	8.0±0.163^{a}	8.0±0.010^{a}	8.0±0.136^{bcd}	8.0±0.043^{de}	8.0±0.065^{de}
	15 days	8.0±0.054^{a}	8.0±0.228^{a}	8.0±0.185^{bc}	8.0±0.032^{de}	8.0±0.032^{de}
	20 days	8.0±0.114^{a}	8.0±0.092^{a}	7.9±0.139^{bcd}	8.0±0.087^{de}	8.0±0.059^{de}

Value of mean± S.D. (n=4)

Mean values with different superscripts in a column within the group differ significantly at $p \leq 0.05$

4. Conclusion

The lifestyle modifications have contributed many disorders to the people due to deprival of needed nutrients from the food they eat. Considering this the multigrain *Nutri-chikki* was prepared by mixing of pumpkin seed, flax seed, groundnut, foxtail millet, almond, roasted bengal gram, black sesame and with unrefined jaggery and corn syrup in order to provide some of the required nutrients. The multigrain *Nutri-chikki* has higher protein and fiber content when compared with the groundnut *chikki*. The mineral content like iron, calcium, magnesium, phosphorus, potassium in multigrain *Nutri-chikki* was also higher than groundnut *chikki* which exists in market. These mineral values are equal to the RDA for children (9-13 yrs old). The standardized multigrain *Nutri-chikki* can be used as snack for people with CVD, stress etc because of the presence of alpha-linolenic acid (ALA) containing nuts. In humans, ALA is an essential fatty acid because it cannot be synthesized from saturated fatty acids, n_9 monounsaturated fatty acids, or n_6 polyunsaturated fatty acids (PUFAs). So it should be obtained from diet through foods and snacks. The consumption of flax or pumpkin seed or the mixtures of these two resulted in a significant decrease in lipid parameters suggesting the antiatherogenic potential of the seed mixture (Barakat and Mahmoud, 2011) [2]. In considering all the above points, it is concluded that the standardized multigrain *Nutri-chikki* is nutrient-dense tasty snack when compared to existing groundnut *chikki*.

5. Acknowledgement

We gratefully acknowledge Food Science and Nutrition Department of Community Science College and Research Institute TNAU for extending its support by providing laboratory facilities for doing this research work.

6. References

1. NRC (National Research Council), Recommended Dietary Allowances, 9th Edn. Nat. Acad. Sci., Washington DC, 1980, 23-34.
2. Barakat LA, Mahmoud RH. The anti-atherogenic, renal protective and immunomodulatory effects of purslane, pumpkin and flax seeds on hypercholesterolemic rats. North America Journal Medical Science. 2011; 3:411-417.
3. Rodriguez-Leyva MD, Bassett MCC, McCullough R, Pierce GN. The cardiovascular effects of flaxseed and its omega-3 fatty acid, alpha-linolenic acid. Canada Journal of Cardiology. 2010; 26(9):489-496.
4. Harper CR, Edwards MJ, DeFilippis AP, Jacobson TA. Flaxseed oil increases the plasma concentrations of cardioprotective (n-3) fatty acids in humans. Journal of Nutrition, 2006; 136:83-87.
5. Medline Plus, 2016. Available at: http://www.nlm.nih.gov/medlineplus/vitamine.html.
6. Chen CY, Lapsley K, Jeffrey Blumberg. A nutrition and health perspective on almonds. Journal of the Science of Food and Agriculture. 2006; 86(14):2245-2250.
7. Lee SH, Chung IM, Cha YS, Park Y. Millet consumption decreased serum concentration of triglyceride and C-reactive protein but not oxidative status in hyperlipidemic rats. Nutrition Research, 2010; 30:290-296.
8. Kanu PJ, Bahsoon JZ, Kanu JB, Joseph Kandeh BA. Nutraceutical Importance of Sesame Seed and Oil: A

Review of the Contribution of their Lignans. Sierra Leone Journal of Biomedical Research. 2010; 2(1):4-16.
9. Yust MM, Pedroche J, Giron-Calle J. Production of ACE inhibitory peptides by digestion of chickpea legumin with alcalase. Journal of Food Chemistry. 2003; 81:363-369.
10. Watts BM, Yumaki CL, Jeffery LE, Elais LG. Basic sensory methods for food evaluation. The International Development Research Centre, Ottawa, Canada, 1989, 159.
11. AOAC. Official Methods of Analysis: Official Method for Moisture. Method No. 925.10. Association of Official Analytical Chemists, Washington DC, 1995.
12. Ranganna S. Hand Book of Analysis and Quality control of Fruit and Vegetable Products. Tata McGraw–Hill Publishing Company Limited, 1995.
13. Ma TS, Zuazaga G. The Microkjeldahl determination of Nitrogen. A new indicator and an improved rapid method. Industrial and Engineering Chemistry. 1942; 14:280-282.
14. Cohen EH. Journal of Assoc. Anal. Chem. 1917; 54:212.
15. Shukla K, Chaturvedi N. Investigation on Preliminary Phytochemical and Proximate Analysis of *Nelumbo nucifera Gaertn* Seeds. International Journal of Pharmacy and pharmaceutical research, 2015, 4(2).
16. Mohamed TK, Zhu K, Issoufou A, Fatmata T, Zhou H. Functionality, *in vitro* digestibility and physicochemical properties of two varieties of defatted foxtail millet protein concentrates. International Journal of Molecular Science. 2009; 10:522-438.
17. Settaluri VS, Kandala CVK, Puppala N. J Sundaram. Peanuts and Their Nutritional Aspects-A Review. Food and Nutrition Sciences. 2012; 3:1644-1650.
18. Cooney RV, Custer LJ, Okinaka L, Franke AA. Effects of dietary sesame seeds on plasma tocopherol levels, Nutrition and Cancer. 2001; 39:66-71.
19. Jaswant Singh, Solomon S, Dilip Kumar. Manufacturing Jaggery, a Product of Sugarcane, As Health Food. Agrotechnology. 2013, S 11.
20. Munro Peacock. Calcium Metabolism in Health and Disease. Clinical journal of the American Society of Nephrology. 2010; 5:S23-S30.