RESEARCH PAPER — FOOD SCIENCE RESEARCH JOURNAL

e ISSN-2230-9403 ■ Visit us : *www.researchjournal.co.in*
Volume 7 | Issue 2 | October, 2016 | 156-164
DOI : 10.15740/HAS/FSRJ/7.2/156-164

Nutrient and chemical profile of raw jackfruit based noodles

VEENA KUMARI AND SUMA DIVAKAR

This study was undertaken to develop a nutrient dense noodles by the incorporation of jackfruit bulb and seed flour and evaluate its chemical and nutritional properties. Noodles based on raw jackfruit bulb flour, raw jackfruit seed flour and refined flour were extruded in various proportion (40:30:30, 50:25:25, 50:30:20, 50:40:10, 50:10:40, 50:20:30). The results of study indicated that samples of jackfruit bulb and seed flour added noodles contained more protein, fibre and minerals and less in energy and carbohydrate as compared to control sample. The noodles developed with addition of jackfruit bulb and seed flour had desirable organoleptic properties. However, based on sensory analysis treatment T_5 (50:10:40) and T_6 (50:20:30) were found to be more acceptable than other treatments.

Key Words : Bulb flour, Extrusion jackfruit, Noodles, Nutrition, Seed flour

How to cite this article : Kumari, Veena and Divakar, Suma (2016). Nutrient and chemical profile of raw jackfruit based noodles. *Food Sci. Res. J.,* **7**(2): 156-164, **DOI : 10.15740/HAS/FSRJ/7.2/156-164**.

INTRODUCTION

A wide range of underutilized fruits are grown in India, whose full potentials are not exploited. This leads to limited scope for marketing of the processed goods outside the region. Besides the seasonal availability of fruits, unsuitable methods of storage and lack of information regarding the nutritional value limits the use of these underutilized fruits (Peter *et al*., 2006). Jackfruit (*Artocarpus heterophyllus* L.) is one such under exploited fruit, which is a member of the Moraceae family, grown sporadically in India as well as in other parts of the tropics mostly as a backyard tree. Although many people prefer jackfruit for its delicious taste, quite a few are unaware of its related health benefits. It is known for its high nutritional and medicinal values. Jackfruit possesses high nutritional value and every 100 g of ripe fruit pulp contains carbohydrate (18.9 g), protein (1.9 g), fat (0.1 g), moisture (77%), fibre (1.1 g), total mineral matter (0.8 g), calcium (20 mg), phosphorus (30 mg), iron (500 mg), vitamin A (540 I.U.), thiamin (30 mg) along with having caloric value of 84 calories and possessing good antioxidant properties (Jagtap *et al*., 2010). There are 100-500 seeds in a single fruit (Sidhu, 2012). The composition of jackfruit seeds has been reported to contain similar compositions as that of grains. The seeds are high in protein, fibre, carbohydrate, vitamins and minerals with moderate amounts of phytochemicals and strong antioxidant properties (Ocloo *et al*., 2010). The fat content of the seed is negligible making it a good constituent of a fat free diet. Jackfruit seed contains lignans, isoflavones, saponins and many more phytonutrients (Omale and Friday, 2010). Seeds contain two lectins namely jacalin and artocarpin. Jacalin has been proved to be useful for the evaluation of the immune

MEMBERS OF RESEARCH FORUM

Author for correspondence :
VEENA KUMARI, Department of Home Science, College of Agriculture, Vellayani, THIRUVANANTHAPURAM (KERALA) INDIA
Emial : weena.yadaw@gmail.com

Associate Authors' :
SUMA DIVAKAR, Department of Home Science, College of Agriculture, Vellayani, THIRUVANANTHAPURAM (KERALA) INDIA
Email : divakarsuma67@gmail.com

status of patients infected with human immunodeficiency virus 1 (Haq, 2006).

Noodle products are staple foods in many parts of Asia, especially throughout South East Asia. Besides, it is often used as a convenience food due to its simple preparation, low cost and fast cooking characteristics. Currently, commercial noodles are rich in carbohydrates, but they are deficient in essential nutrients, such as proteins, dietary fibre, vitamins and minerals which are lost during wheat flour refinement. Thus, this study was conducted to develop and evaluate the quality of noodles produced from raw jackfruit, which represents a major end-use of wheat and which is suitable for enhancing health, after incorporating sources of fibre and essential nutrients.

METHODOLOGY

The experiment was conducted at the Department of Home Science, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during the year 2013-2015. Jackfruit variety "*Koozha*" was selected for the study owing to its abundant availability and lower utilisation. Raw mature jackfruits were harvested from the trees grown in the Instructional farm, College of Agriculture, Vellayani and also from the adjacent home yards, for the study purpose.

Preparation of flour:

The flour was prepared from the raw jackfruit bulbs (JFBF) and seeds (JFSF) were prepared by milling of dried bulbs and seeds and their quality was analysed for chemical and nutritional.

Preparation of noodles:

Composite flour was prepared in six different combinations of refined flour, bulb flour and seed flour. The flour was kept in the Brabender single screw food extruder for extrusion of noodles. The details of combinations are presented in Table A.

Quality analysis of flours and noodles :

Quality of the flour and noodles were assessed by using standard procedures as depicted in Table B.

Bulk density:

Fifty grams of the sample were put into 100 ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained. The bulk density (g cm^{-3}) was calculated as weight of sample (g) divided by volume of sample after tapping (cm^3) (Okaka and Potter, 1979).

$$\text{Bulk density} = \frac{\text{Weight of the sample}}{\text{Weight of equal volume of water}}$$

Statistical analysis:

Statistical analyses of the obtained data were subjected to analysis of variance (ANOVA) using complete randomized design. Critical difference at

Table A : Combinations of composite flour (100g)

Sr. No.	Treatments	Refined flour (maida)	Jackfruit bulb flour (JFBF)	Jackfruit seed flour (JFSF)
1.	T_1	40	30	30
2.	T_2	50	25	25
3.	T_3	50	30	20
4.	T_4	50	40	10
5.	T_5	50	10	40
6.	T_6	50	20	30

Table B : Methods of analysis of physical chemical and nutritional constituents of RJF

Constituents	Method adopted
Bulk density (g/cm^3)	Okaka and Potter (1979)
Fibre (g)	AOAC (2005)
Moisture (%)	AOAC (2005)
Carbohydrate (g)	AOAC (2005)
Protein (g)	AOAC (2005)
Calories (kcal)	AOAC (2005)
Total minerals (mg)	AOAC (2005)

($p \leq 0.05$) was estimated and used to find significant difference, if any.

OBSERVATIONS AND ASSESSMENT

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Physical, chemical and nutritional qualities of flours:

Bulk density is a measure of heaviness of a flour sample. It is affected by the particle size of the samples and is important for determining packaging requirements, material handling and for various other applications in wet processing in the food industry (Ocloo *et al*., 2010). In the present study bulk density was found to be higher in bulb flour (0.96 g/cm^3) than seed flour (0.92g/cm^3). Though there was a slight difference in the bulk density of both types of flour, it was not statistically significant as shown in Table 1. from the t values. This may be due to variations in particle size of the products because bulk density is generally affected by the particle size of the flour. The value obtained is higher than reported in literature. Since flours with high bulk density are used as thickeners in food products, the jackfruit seed flour studied could be used as a thickener as well (Ocloo *et al*., 2010). Odoemelam (2005) also reported a bulk density value of raw flour from jackfruit seeds to be about 0.61g/ml. Ocloo *et al*. (2010) obtained the bulk density of jackfruit seed flour to be 0.80 g/cm^3.

Crude fibre content of bulb flour was higher (4.06g) than seed flour which had a fibre content of 3.13g. Ocloo *et al*. (2010) reported that JF seed flour had 3.19 g fibre whereas Munishamanna (2012) reported that JF bulb flour had 1.8g fibre in 100g. This difference may be due to varietal difference.

Moisture provides a measure of the water content of the seed flour and for that matter its total solid content. It is also an index of storage stability of the flour. In this study seed flour showed the higher moisture value (7.97%) than bulb flour (7.23%). Abraham and Jayamuthunagai (2014) reported that the moisture content of the seed flour was 7.75 per cent. The lower the moisture contents of flour, the better its shelf-stability and the quality. Moisture content of flour generally depends on the duration of the drying process. Ocloo *et al*. (2010) reported that the moisture content of the jackfruit seed flour was 6.09 per cent. Munishamanna (2012) reported that jackfruit bulb flour had a moisture content of 5.2 per cent. Mahmood (2004) reported that moisture content of wheat and maize varieties depended largely on the genetic makeup and is also influenced by the agronomic and climatic conditions.

Carbohydrate content was found to be higher (81.46 g) in seed flour in comparison to bulb flour (74.12 g). Abraham and Jayamuthunagai (2014) had reported that JF seed flour had a carbohydrate content of 70.73g whereas Ocloo *et al*. (2010) reported that JF seed flour had a carbohydrate content of 79.34 per cent. This variation may be due to variety or cultural factors.

Significant difference in protein content could be observed in seed flour (10.48g) and bulb flour (1.53g). In the present context, protein content was found to be higher in seed flour (10.48g) than bulb flour (1.53g). Ocloo *et al*. (2010) reported that protein content of JFS flour is 13.50g, whereas Abraham and Jayamuthunagai (2014) reported that protein content of JFS flour has 13.49g. Munishamanna (2012) reported that JF bulb flour had a protein content of 1.05g. This may be due to the

Table 1 : Physical, chemical and nutritional content of jackfruit flour

Sr. No.	Physical/chemical/nutritional characteristics	Bulb flour (100g)	Seed flour (100g)	t value
1.	Bulk density (g/cm3)	0.96	0.92	3.15
2.	Fibre (g)	4.06	3.13	74.56**
3.	Moisture (%)	7.23	7.97	99.72**
4.	Carbohydrate (g)	74.12	81.46	217**
5.	Protein (g)	1.53	10.48	13420**
6.	Energy (kcal)	329.88	353.87	2169**
7.	Calcium (mg)	30	308.56	476.95**
8.	Potassium (mg)	328.11	1478. 37	1792.28**
9.	Sodium (mg)	35.06	60.63	1025**
10.	Magnesium (mg)	0.13	338.04	10806**

Results are expressed as mean values of three replicates **indicates significance of value at P=0.05

fact that fruits and vegetables are not as concentrated with respect to macro nutrients. In this study seed flour was observed to have an energy value of 353 kcal whereas, bulb flour had 329 kcal. Ocloo *et al*. (2010) reported the calorie value of seed flour to be 382 kcal/ 100g. Abraham and Jayamuthunagai (2014) reported that the calorific value of seed flour was 358 kcal/100g.

In case of minerals too, seed flour had shown higher values than bulb flour. Potassium content was higher on dry weight basis in seed flour (1478.37 mg) than bulb flour which had 328.11mg/100. Magnesium was also found to be higher in seed flour 338.04 mg than bulb flour (0.13 mg). Sodium (60.63mg) and calcium (308.56 mg) was found to be higher in seed flour compared to bulb flour which showed 35.06 mg of sodium and 30 mg of calcium, respectively. The study revealed that JFB flour contained potassium (328.11 mg), magnesium (0.13 mg), sodium (35.06) and calcium (30 mg). Seed flour was observed to contain potassium (1478.37), magnesium (338.04), sodium (60.63) and calcium (308.56 mg). The jackfruit seed flour was observed to contain an appreciable value of calcium (3087 mg/kg), potassium (1478 mg/kg), sodium (60.66 mg/kg) as reported by Ocloo *et al*. (2010). Abraham and Jayamuthunagai (2014) reported that seeds were rich in potassium (6466 ppm), magnesium (4582 ppm) and sodium (8906 ppm).

Chemical and nutritional qualities of noodles :

Chemical composition of noodles :

Chemical compositions of developed noodles were assessed with respect to moisture and fibre content and it was compared with control (commercial noodles).

Moisture:

Moisture content of the dried product is an indicator of efficiency of dehydration. When moisture content of noodles was analysed, it was found that all the treatments had significantly higher moisture value than control (5.79 %) and it ranged from 6.40 to 6.45 (Table 2). Though all treatments showed almost similar moisture content, their value was found to be higher in T_5 (6.47) and it was at par with T_6 with a value of 6.45. This may be because seed flour contains higher moisture and, therefore, may be more hygroscopic in nature than bulb flour. The lowest moisture content was observed in T_4 (6.40) and T_1 (6.40). The reason in variation may be because the developed treatments had different ratios of refined flour, raw jackfruit bulb flour and raw jackfruit seed flour. Meanwhile, the moisture content of commercial noodles was found to be 5.79 per cent. Lower moisture content in commercial noodles may be because of the additives that are added to maintain the moisture level. This observation is in line with the findings of Akanbi *et al*. (2011) who had observed that moisture content of bread starch (BS) and wheat flour (WF) noodles ranged from 4.65 (60% BS:40% WF) to 5.45 per cent (100% BS:0% WF). They also reported that these values are far lower than the Joint FAO/ WHO standards for fried and non-fried instant noodles, which are 10 and 14 per cent, respectively (FAO/ WHO, 2003). An inference can therefore be drawn that RJF noodles apart from being healthy and free of additives, also conform to the standards of world food and health regulatory agencies.

Fibre :

Plant foods, have indigestible complex molecules, namely fibre which contribute to the bulk of intestinal contents thus serving the digestive tract. Fibre content of the noodles ranged from 4.57 to 5.42g. In present study, crude fibre was present in higher concentration in all the treatments. This is because both the bulb and seed flour

Table 2 : Nutritional and chemical composition of food (100g)

Treatments	Energy (kcal)	CHO (g)	Protein (g)	Total minerals (mg)				Fibre (g)	Moisture (%)
				Ca	K	Mg	Na		
T_1	336.33	57.04	10.61	110.63	593.40	122.50	32.31	5.07	6.40
T_2	291.60	59.41	12.03	96.13	516.54	111.70	28.44	4.96	6.45
T_3	357.30	56.11	10.12	79.30	426.13	94.35	23.67	5.26	6.41
T_4	350.86	48.89	10.64	45.36	245.36	60.49	14.38	5.42	6.40
T_5	380.93	70.91	13.49	146.94	787.33	162.24	42.73	4.57	6.47
T_6	366.93	63.54	12.92	113.11	606.53	128.29	33.23	4.77	6.45
T_7 (control)	372.00	81.50	11.50	*	*	*	*	0.03	5.79
C.D. (P=0.05)	1.460	0.886	0.302	0.279	0.497	0.958	0.470	0.061	0.108

Results are expressed as mean values of three replicates) (*- not displayed)

contained high amounts of fibre. Their value was found to be higher in T_4 and T_3. The combination of RF: RJBF: RJSF in T_4 and T_3 were 50:40:10 and 50:30:20, respectively. From the study it was also observed that as the amount of bulb flour increased in treatments, the value of fibre content was also increased. The reason for high fibre in general is due to jackfruit especially *Koozha* cultivar. Hence, RJF noodles could be acceptable in places where high fibre diets and lower fatty foods are desired. Supplementation of jack fruit seed flour to the wheat flour in bread increased fibres and slightly decreased protein (Ejiofor *et al*., 2014). The maximum fibre content was noted for T_4 (5.42) and least fibre was recorded for T_7 (control- 0.03g). Dietary fibre components exert beneficial effects mostly by way of their swelling properties and thereby increasing transit time in the small intestine. Consequently, they reduce the rate of release of glucose and its absorption, thus help in the management of lifestyle disease. Dietary fibre components also bind to bile salts, thereby promoting cholesterol excretion from the body and thus reducing blood cholesterol levels and food toxins in the gut (Gopalan *et al*., 2009). Fibre content of commercial noodles was found to be of negligible quantity. This is because commercial noodle are made of refined flour which is a poor source of dietary fibre. Kulkarni *et al*. (2012) found 3.6 and 3.80 g of crude fibre in 30 per cent unmalted and malted *Ragi* flour noodles and also reported that their concentration was high due to *Ragi* which is good source of fibre. Yadav and Gupta (2015) reported that dietary fibre level varied in direct proportion with the amount of apple pomace powder. The control samples showed low value of dietary fibre while the noodles containing 10 per cent apple pomace powder possessed 13.28 per cent total dietary fibre. In another study Pereira and Ludwig (2001), reported that high-fibre diets are associated with lower food intake as this triggered maximal sensory stimulation in the mouth due to increased need for chewing.

Nutrient composition of noodles :

In recent years, there have been significant changes in the preference of consumers for foods that are healthier, have higher nutritional quality and are more exotic. Traditional foods satisfied these parameters adequately. New food products should thus be developed based on these principles. Individual food manufacturers must respond rapidly to these changes in order to remain competitive within the food industry. WHO and FAO strongly recommend food manufacturers to develop innovative nutrient rich convenient foods from natural sources (Astrup *et al*., 2008). Nutritional compositions are also attracting consumers to make sure that there are definite proportions of nutrients in each food. Food manufacturers also recognize the importance of safe and healthy foods (Rivera *et al*., 2004). Hence, nutrient assessment is an inevitable part of a new product development.

Proximate composition:

The nutrients analysed were energy, protein, carbohydrate and minerals. Man needs a wide range of nutrients to perform various functions in the body and to lead a healthy life. Most food contains almost all the nutrients in various proportions, some foods being rich in certain nutrients.

Energy:

Energy is essential for growth, maintenance, activity and rest (Sheng *et al*., 2010). Energy content of all the treatments ranged from 291.60 – 372.00 kcal which included control. When the energy value of the developed treatments were computed, it was found that energy value was found to be higher in T_5 (380.86 kcal) and lower in T_2 (291.60). Energy value of T_7 (control) obtained the second highest score (372.00). All other treatments T_6 (366.93 kcal), T_3 (357.30 kcal), T_4 (350.86 kcal) and T_1 (336.33 kcal) were less than T_7 (control). Table also revealed that the differences in energy values of treatments and control were statistically significant. Among the treatments energy content was found to be higher in T_5 (380.86 kcal) and T_6 (366.93 kcal). This may be because these two treatments had higher seed flour content compared to all other treatments. The value of energy content was found to be higher than control (372.00 kcal). The reason for such a variation is because composite flour had protein content which is also considerable source of energy as carbohydrate.

Carbohydrate :

Intake of carbohydrate from vegetables, fruits, whole grains, legumes and dairy products is advisable over intake from other carbohydrate sources especially those that contain added fats, sugar or sodium (Alison *et*

al., 2014). It is one of the most abundant and widespread organic substances in nature. It is generally regarded as an immediate and cheap energy source. Table gives the carbohydrate content of different treatments of developed noodles. The statistical analysis of data revealed that there was a significant difference between carbohydrate content of the developed noodles. In the present study carbohydrate content was found to be higher in T_5 (70.91g) and T_6 (63.54g) in the proportion of RF: RJBF: RJSF as 50:10:40 and 50:20:30, respectively however, their value was lower than control (81.50g) but these values were higher than all other treatments. This was followed by T_6 with the score of 63.54. This difference in carbohydrate content in comparison to control is because commercial noodles are made from refined flour which is rich in starch. Among the treatments T_5 and T_6 had more seed flour which is also rich in starch content. Results further revealed that as the concentration of bulb flour increases, carbohydrate content was found to be decrease. Yadav and Gupta (2015) reported that the formulation with 10 per cent apple pomace powder and wheat flour had carbohydrate content of 67.20 per cent.

Protein:

It is one of the most important nutrients required by the body to carry out a wide range of functions and essential for the maintenance of life (Gopalan *et al*., 2009). The protein content of the developed noodles is depicted in Table 2. which ranged from 10.12 – 13.49g. Protein content was also notably high in T_5 (13.49g) T_6 (12.92g) and T_2 (12.03) treatments and it was also found to be higher than control (11.50g). This may be because these treatments contained more amount of seed flour which is a rich source of protein. Since refined flour has lower protein content, commercial noodles have lower protein than developed noodles. The data further revealed that 3 treatments T_4, T_1 and T_3 had lower protein content (10.64g, 10.61g and 10.12g, respectively) than control. These findings are in agreement with the findings of Abraham and Jayamuthunagai (2014), who found that crude protein of the seed flour, was 13.49 per cent. Amin (2009) reported that jackfruit seed in noodles increased the protein content and improved the overall nutritional value of the noodles.

Minerals:

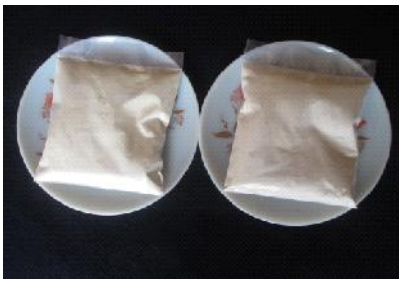
Mineral content of treatments shows the presence of essential minerals like calcium, potassium magnesium and sodium. The mineral content of the developed noodles are depicted in Table 2.

Calcium:

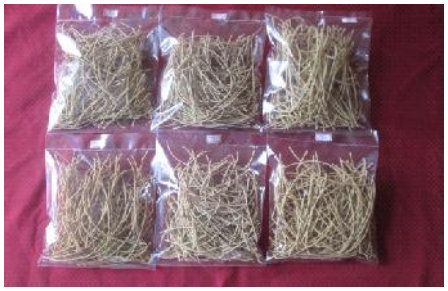
It is essential for all living organisms especially for the cell physiology. As a major material used in mineralization of bone, teeth and shells, calcium is the most abundant macro mineral by mass in most animals.

Raw mature bulb

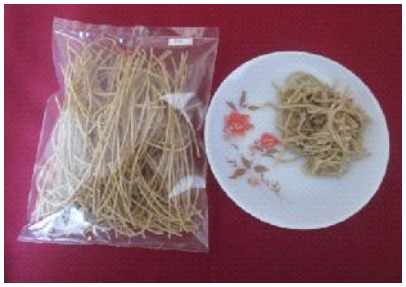
Seed



Bulb and seed flour



Packed noodles



Cooked noodles

The calcium content of the developed noodles is depicted in table. Results emphasize that there was significant differences in calcium content in selected treatments of noodles. The maximum calcium content was noted for T_5 (146.94 mg) followed by T_6 (113.11mg), T_1 (110.63 mg), T_2 (96.13 mg) and T_3 (79.30 mg). The minimum calcium content was recorded for T_4 (45.36 mg). Mineral content of noodle was found to be higher in all treatments. The differences observed could be attributed to the variety of jackfruit. Calcium has an important role in prevention and treatment of osteoporosis (together with vitamin D), colorectal cancer, kidney stones (Hall, 2002).

Potassium:

It is an essential macro-mineral in human nutrition as it is the major cation inside animal cells. It is important for maintaining the fluid and electrolyte balance in the body. Potassium is also important in conducting muscle contraction and in the sending of nerve impulses in animals through cation potential. Potassium content of different treatments is depicted in Table 2. It was seen to be highest for T_5 (787.33 mg) followed by T_6 (606.53 mg), T_1 (593.40mg) and T_2 (516.54 mg). The minimum potassium content was recorded for T_4 (245.36 mg).

Magnesium:

It is highly required for cellular metabolism, essential for the intracellular enzyme activities, metabolism of carbohydrate and as structural components of DNA and RNA. The magnesium content of the developed noodles is recorded in Table 2. From the table it is noted that there was significant difference in the magnesium content of the developed noodles. Its level ranged from 60.49 – 162.24 mg. Mg content was found to be high in T_5 (162.24 mg) and it was followed by T_6 (128.29mg) and T_1 (122.50 mg). The lowest magnesium content was found in T_4 (60.49 mg). Magnesium is important for prevention or treatment of hypertension and heart diseases, diabetes, osteoporosis, migraine, headaches and asthma (Tucker *et al*., 1999).

Sodium:

It plays a very significant role in maintaining intracellular fluid and electrolyte balance. The result elucidated that T_5 had the highest sodium content (42.73). The second highest content was found in T_6 (33.23 mg) and T_1 (32.31 mg). The lowest sodium content was observed for T_4 (14.38 mg) as represented in the Table 4. From the table it clear that T_5 revealed higher values for total mineral where as it was lowest in T_4. Minerals content was not displayed in T_7 (commercial noodles). The amount of calcium (146.94 mg), potassium (787.33 mg), magnesium (162.24 mg) and sodium (42.73 mg) were found to be high in T_5. This observation may be because jackfruit seed flour is rich source of minerals. This is in line with the finding of Ocloo *et al.* (2010), who stated that jackfruit seed flour prepared is rich in calcium (3087 mg/kg), magnesium (3380 mg/kg) and potassium (14781 mg/kg). Dried drumstick leaves incorporated into rice flour at 3 per cent is recommended for manufacturing noodles having higher amount of calcium as reported by Wijesiri *et al*. (2014).

In general nutritional and chemical composition of the study revealed that presence of analysed chemical constituents like moisture was higher in T_5 and T_6 and fibre content was high in T_4 and in T_3. With respect to nutritional quality, T_5 and T_6 showed higher nutrients. Amin (2009) reported that chemical composition in noodles substituted with jackfruit seeds indicated decrease in fat and moisture content compared to control noodles and ash and crude fibre contents in 30 per cent substitution of jackfruit seed flour were higher than that of control noodles.

Conclusion:

The results of the present study revealed that beneficial noodles with health promoting factors can be produced from blends of raw jackfruit bulb flour and raw jackfruit seed flour. Throughout the study, noodles produced from blends of bulb flour and seed flour showed superior proximate, culinary and sensory attributes. Both bulb and seed flour are high in nutrients like protein, fibre, minerals and low in energy and carbohydrate, which is established to reduce symptoms of chronic constipation, heart diseases associated with high cholesterol, diverticular diseases and risk of colon cancer. Therefore, an inference can be drawn that raw jackfruit based noodles are more than just noodles, but important functional foods.

Acknowledgement :

This project was supported by Central tuber crop research institute, Srikaryam, Thiruvanathapuram. The fellowship for project was provided by Kerala Agricultural

University is gratefully acknowledged.

LITERATURE CITED

Abraham, A. and Jayamuthunagai, J. (2014). An analytical study on jackfruit seed flour and its incorporation in pasta. *Res. J. Pharma. Biol. Chem. Sci.,* **5**(2): 1597-1610.

Akanbi, T.O., Nazamid, S., Adebowale, A.A., Farooq, A. and Olaoye, A.O. (2011). Breadfruit starch-wheat flour noodles: preparation, proximate compositions and culinary properties. *Internat. Food Res. J.,* **18** : 1283-1287.

Alison, B.E., Jackie, L.B., Marjorie, C. and Stephanie, A. (2014). Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes Care*, **37**(1): 41-44.

Amin, M.F.S. (2009). Optimization of jackfruit seed (*Artocarpus heterophyllus* Lam.) flour and polydextrose content in the formulation of reduced calorie chocolate cake. University Sains. Malaysia.

A.O.A.C. (2005). *Association of official analytical chemists*, 2005.974.24.

Astrup, A., Dyerberg, J. and Selleck, M. (2008). Nutrition transition and its relationship to the development of obesity and related chronic disease. *Obesity,* **1** : 48-52.

Ejiofor, J.E., Beleya, E.A. and Onyenorah, N.I. (2014). The effect of processing methods on the functional and compositional properties of jackfruit seed flour. *Internat. J. Nutr. Food Sci*., **3**: 166-173.

FAO/WHO (2003). Food Standards Programme Codex Committee Alimentarius Commission, ROME, ITALY.

Gopalan, C., Ramasastri, B.V. and Balasubramanian, S.C. (2009). Nutritive value of Indian foods. NIN, ICMR, Hyderabad, 47p.

Hall, P.M. (2002). Preventing kidney stones: calcium restriction not warranted. *Cleve. Clin. J. Med*., **69**(11): 885-888.

Haq, N. (2006). Jackfruit (*Artocarpus heterophyllus)*. Southampton centre for underutilised crops. University of Southampton, Southampton, U.K.

Jagtap, U.B., Panaskar, S.N. and Bapat, V.A. (2010). Evaluation of antioxidant capacity and phenol content in jackfruit (*Artocarpus heterophyllus* Lam.) fruit pulp. *Plant Foods Hum. Nutr*., **65** : 99-104.

Karoline, K.D. (2004). Formulating extruded foods based on dioscorea *Dioscorea rotundata* Poir) and taro (*Colocasia esculenta* L.). M.Sc.(FSN) Thesis, Kerala Agricultural University, 125p. Thrissur, KERALA (INDIA).

Kulkarni, S.S., Desai, A.D., Ranveer, R.C. and Sahoo, A.K. (2012). Development of nutrient rich noodles by supplementation with malted *Ragi* flour. *Internat. Food Res. J.,* **19**(1): 309-313.

Mahmood, A. (2004). Gliadin composition and cluster analysis for quality traits of different wheat varieties. Ph.D. Thesis, Department Food Technology University, Agriculture. Faisalabad. 226p.

Munishamanna, K.B. (2012). Development of value added products from jackfruit bulb. *Mysore J. Agric. Sci*., **46**(2): 426-428.

Ocloo, F.C.K., Bansa, D., Boatin, R., Adom, T. and Agbemavor, W.S. (2010). Physico-chemical, functional and pasting characteristics of flour produced from jackfruits (*Artocarpus heterophyllus* Lam.) seeds. *Agric. Biol. J. N. Am*., **1**(5): 903-908.

Odoemelam, S.A. (2005). Functional properties of raw and heat processed jackfruit flour. *J. Pakistan Nutr*., **4** (6): 366-370.

Okaka, J.C. and Potter, N.C. (1979). Physiochemical and functional properties of cowpea powders processed to reduce beany flavour. *J. Food. Sci*., **4** : 1235-1240.

Omale, J. and Friday, E. (2010). Phytochemical composition, bioactivity and wound healing potential of *Euphorbia heterophylla* (Euphorbiaceae) leaf extract. *Internat. J. Pharm. Biomed. Res.,* **1**(1): 54–63.

Pereira, M.A. and Ludwig, D.S. (2001). Dietary fibre and body weight regulation- Observation and mechanisms. *Pediatr. Clin. N. Am*., **48**(4) : 969-80.

Peter, K.V., Rajan, S. and Baby, L.M. (2006). *Propagation of Horticultural Crops*. New India Publishing Agency, New Delhi, 270p.

Rivera, J.A., Barquera, S. and Costa, T. (2004). Nutrition transition in Mexico and in other Latin America countries. *J. Food Microbiol.,* **5**(2): 293.

Sheng, Z., Wei, H., and Hua, T.D. (2010). Dietary alpha-linolenic acid and mixed tocopherol and packaging influence lipid stability in broiler chicken breast and leg muscle tissue. *J. Food Sci*., **60** : 1013-1018.

Sidhu, A.S. (2012). Jackfruit improvement in the asia-pacific region a status report, IIHR 1-20p.

Swami, S.B., Thakor, N.J., Sanjay, O. and Kalse, S.B. (2014). Development of osmo-tray dried ripe jackfruit bulb. *J. Food Res. Technol*., **2**(2): 77-86.

Tucker, K.L., Hannan M.T., Chen, H., Cupples L.A., Wilson,

P.W. and Kiel, D.P. (1999). Potassium, magnesium and fruit and vegetable intakes are associated with greater bone mineral density in elderly men and women. *Am. J. Clin. Nutr*., **69**(4): 727-736.

Wijesiri, V.T., Illeperuma, C.K. and Sarananda, K.H. (2014). Development of rice noodles by incorporating *Moringa oleifera* (drumstick) leaves for calcium enrichment (abstract) proceedings of the peradeniya univ. International research sessions, Srilanka, vol. 18, 4th and 5th July, 2014. abstract no: 196 food, nutrition and livestock.

Yadav, S. and Gupta, R.K. (2015). Formulation of noodles using apple pomace and evaluation of its phytochemicals and antioxidant activity. *J. Pharmacognosy Phytochemistry*, **4**(1): 99-106.

Received : *01.02.2016;* **Revised:** *19.07.2016;* **Accepted :** *05.08.2016*