ANALYSIS

4(11), May 1, 2013

ISSN 2278–5469 EISSN 2278–5450

Discovery

Study on utilization of Jackfruit seed flour and de-fatted soy flour mix in preparation of breakfast cereal by twin-screw extrusion technology

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Publication History
Received: 13 March 2013
Accepted: 20 April 2013
Published: 1 May 2013

Citation
Priyadarshini Chakraborty, Bhattacharyya DK, Bandyopadhyay NR, Ghosh M. Study on utilization of Jackfruit seed flour and de-fatted soy flour mix in preparation of breakfast cereal by twin-screw extrusion technology. *Discovery*, 2013, 4(11), 32-37

General Note
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ABSTRACT

The work aims at developing nutritionally enriched breakfast cereal by utilizing the jackfruit seed flour, and defatted soy flour, by Twin-screw Extrusion technology. Jackfruit seed flour and defatted soy flour are used as major sources of raw materials in four different set of compositions and are subjected to extrusion to prepare nutritious extruded breakfast cereals. Other ingredients used are milk powder (Amul), sugar powder, cocoa powder (WeiKFiELD) and Salt (Iodised Tata salt). The products showed better nutrient composition in terms of Protein, Carbohydrate, Minerals and Fiber. Results showed that the Extruded Breakfast Cereal A (EBCA) has protein (18.2±0.26gm/100gm), carbohydrate (70.6±0.24 gm/100gm), ash (3.2±0.03gm/100gm), fiber (3.8±0.05gm/100gm) and fat (0.7±0.01gm/100gm); Extruded Breakfast Cereal B (EBCB) has protein (18.3±0.28gm/100gm),carbohydrate (70.0±0.19gm/100gm),ash (3.2±0.02gm/100gm), fiber (3.8±0.06gm/100gm) and fat (0.7±0.02gm/100gm); Extruded Breakfast Cereal C (EBCC) has protein (20.0±0.24gm/100gm), carbohydrate (68.3±0.22 gm/100 gm), ash (3.3±0.05gm/100gm), fiber (3.9±0.02gm/100gm) and fat (0.8±0.05gm/100gm); Extruded Breakfast Cereal D (EBCD) has protein (18.6±0.26gm/100gm), carbohydrate (68.5±0.02gm/100gm), ash (3.1±0.06gm/100gm), fiber (3.8±0.04gm/100gm) and fat (1.3±0.03gm/100gm) as compared to control extruded breakfast cereal. The extruded breakfast cereal contained good amount of minerals examined (Na, K, Fe, Cu, Zn, Ca and Mg). Na content was found to be much lower as compared to control extruded breakfast cereal. The four sets of breakfast cereal are also very low in moisture percentage as

compared to the control extruded breakfast cereal indicating lower water activity and possess lesser chance of microbial growth. When added to milk, both hot (lukewarm) and cold, the products showed stability and remained floating.

Keywords: Breakfast cereal, jackfruit seed flour, de-fatted soy flour, Twin-screw Extrusion Technology

Abbreviation: EBCA- Extruded Breakfast Cereal A; EBCB- Extruded Breakfast Cereal B; EBCC- Extruded Breakfast Cereal C; EBCD- Extruded Breakfast Cereal D

1. INTRODUCTION

Ready-to-eat breakfast cereals are defined as processed grain formulations suitable for human consumption without further cooking. Well-known extrusion applications in the food industry include ready-to-eat breakfast cereals, baby foods, pet foods, and confectionery products. The most used raw materials in the extrusion process are starch and protein based materials. The structure of the extruded products may be formed from starch or protein polymers. Most products, such as breakfast cereals, snacks and biscuits are formed from starch, while protein is used to produce products that have meat-like characteristics and that are used either as full or partial replacements for meat in ready meals, dried foods and many pet food products (Guy, 2001). The use of raw materials with high protein contents in extrusion began around the 1970s, with the use of soy for the production of texturized soy products and meat analogues (Ledward & Mitchell, 1988; Mitchell & Areas, 1992). Jackfruit (*Artocarpus heterophyllus* Lam) is popular fruit crop that is widely grown in India, Bangladesh and other tropical areas. The seeds make-up around 10 to 15% of the total fruit weight and have high carbohydrate and protein contents (Bobbio et al 1978).

The seeds are eaten after boiling or roasting, or dried and salted as table nuts, or ground to make flour which is blended with wheat flour for baking. The seed starch is given to relieve biliousness. Roasted seeds are regarded as an aphrodisiac. Increased consumption of ripe jackfruit kernels alleviates vitamin A deficiency. Extract from fresh seeds cures diarrhoea and dysentery. Extract from seeds helps digestion (Haq, 2006). Jackfruit seeds can be used in brine alone or in curried form, similar to the use made of immature fruits, by eliminating trypsin inhibitors through heating (Siddappa, 1957). A project was undertaken for determining the physico-chemical and functional properties of jackfruit seed by, Abedin et al, (2012). Some functional properties of jackfruit seed flour and its protein digestibility was reported by Singh et al. (1991). Jackfruit seed have been utilized in the preparation of biscuits. A study on the standardization of jack seed based biscuits was conducted, physical parameters of jackfruit seed flour incorporated biscuits was studied. Jackfruit seed flour has been used in preparation of convenience food. An attempt has been made to blend 10-50 per cent jack seed flour for biscuit preparation on wheat flour replacement basis (Samata Airani, November 2007).

Figure 1
Extruded Breakfast Cereal A

Figure 2
Extruded Breakfast Cereal B

Figure 3
Extruded Breakfast Cereal C

Figure 4
Extruded Breakfast Cereal D

Characterization of Ready-to-Eat Composite Porridge Flours Made by Soy-Maize-Sorghum-Wheat Extrusion Cooking Process was done. The materials used included sorghum, maize, wheat and soybean and two composite flours were formulated Sorghum-Maize-Soy 1 (SMS1) and Sorghum-Maize-Soy 2 (SMS2). Nutritional and functional characteristics of the two products were determined after High Temperature Short Time (HTST) extrusion (Murekatete Nicole et al. 2010). Physiological effects of products obtained by nixtamalization and extrusion of quality protein maize was studied (Maria del Carmen Robles-Ramirez et al. 2011). Study was undertaken on Effect of twin-screw extrusion parameters on mechanical hardness of direct-expanded extrudates (M BRN˘ CI´Ca et al. 2006). Maternal and child under nutrition remain pervasive and damaging conditions in low income and middle-income countries (Black et al. 2008, Murekatete Nicole, 2010) like ours. Protein Energy malnutrition (PEM) and micro-nutrient malnutrition is still very much prevalent in our country. To combat this problem utilization of seed protein and oil meals (which are also rich in protein) should be undertaken. Exploitation of Twin screw extrusion technology in this field of study will be made to produce protein rich extruded food. This project aimed at utilization of jackfruit seed flour and de-fatted soy flour in preparation of breakfast cereal and determining the sensory, physical and nutritional properties in order to explore its potentials in food systems.

2. SCOPE OF THE SUDY

The aim of carrying out this research is to utilize jackfruit seed, which is otherwise considered a fruit waste, in preparation of nutritious extruded food. Keeping in mind that the seeds are perishable and available seasonally, the seed can be preserved as seeds flour and used in food preparation. The seeds are nutrient rich and thus cannot be wasted. De-fatted soy flour which is a protein rich flour is used along with jackfruit seed flour to make the extruded products even more nutritious.

3. MATERIALS AND METHODS

3.1. Raw materials

Jackfruit seed, Soybean, Milk powder (Amul), Sugar powder, Cocoa powder (WeiKFiELD), Salt (Iodised Tata salt) were purchased from local market of Kolkata and Howrah, India

3.2. Reagents/Chemicals

Anthrone reagent, Folin Reagent, Sodium Hydroxide, Ethyl alcohol, Di-ethyl ether, and n-Hexane and other chemical reagents and solvents used, are from Merck, India.

3.3. Preparation of Breakfast Cereal

3.3.1. Preparation of Jackfruit seed Flour

The jackfruit seeds were cleaned manually and white arils were manually peeled off. Seeds were lye peeled, to remove the thin brown cover. The seeds are washed thoroughly between the hands under running water. The lye peeled seeds were sliced into thin chips and dried at 50- 60° C in a drying oven to constant moisture. The dried chips were grinded using a mixer grinder, (Bajaj, GX10) to get flour.

3.3.2. Preparation of Defatted Soy Flour

Decorticated Soybeans are dried in drying oven. The dried seeds are grinded in a mixer grinder, (Bajaj, GX10) to get whole flour. Oil was extracted from the whole seed flour by solvent extraction method. The deoiled cake was made solvent free and grinded in mixer to get Defatted Soy flour.

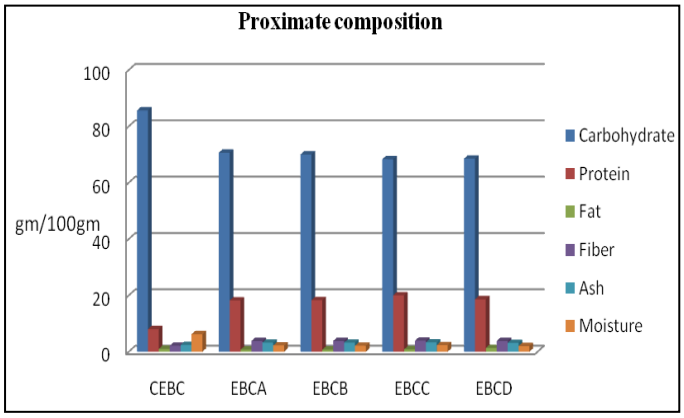

Figure 5

Comparison of proximate composition of extruded breakfast cereals with the control

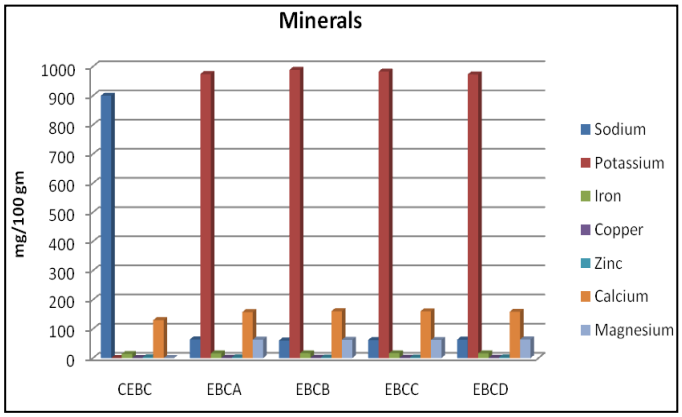

Figure 6

Comparison of minerals of extruded breakfast cereals with the control

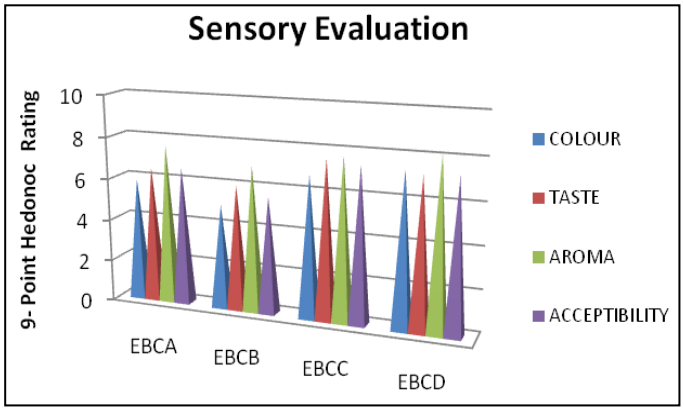

Figure 7

Sensory evaluation of the extruded breakfast cereals on the basis of 9-Point Hedonic Rating

3.3.3. Process for preparation of breakfast cereal

The breakfast cereals were prepared of varying composition using Jackfruit seed flour, soy flour, sugar, milk powder, cocoa powder and salt. All the ingredients, except the soy flour were mixed together in appropriate amount and moisture was adjusted at 5-6%. This mixture was allowed to pass through a 100 mesh screen. Soy flour was added to the mixture after moisture adjustment and sieving. After this the mixture was allowed to condition for 30 minutes by keeping them in food grade poly bags. Temperature, rpm and cutting speed were adjusted while extruding in the Twin Screw extruder. The temperature of the heaters, speed of extruder and cutter are listed in Table 1. After conditioning, the ingredients were fed in the twin-screw extruder [SL. No – BTPL LAB Model (EB – 10) Twin Screw Extruder]. Extruded products were collected, cooled and stored.

3.3.4. The products were distinguished as

1. Extruded Breakfast Cereal A- EBCA (Fig.1)
2. Extruded Breakfast Cereal B- EBCB (Fig.2)
3. Extruded Breakfast Cereal C- EBCC (Fig.3)
4. Extruded Breakfast Cereal D- EBCD (Fig.4)

3.3.5. Compositions used in the Different Breakfast Cereals are follows

EBCA includes: Jackfruit seed flour (150gm), Soy flour (50 gm), Milk powder (20 gm), Sugar powder (30 gm), Moisture (5-6%).
EBCB includes: Jackfruit seed flour (140 gm), Soy flour (60 gm), Sugar powder (40 gm), Cocoa powder (10gm), Moisture (5-6%).
EBCC includes: Jackfruit seed flour (140 gm), Soy flour (60 gm), Milk powder (20 gm), Sugar powder (20 gm), Cocoa powder (10 gm), Moisture (5-6%).
EBCD includes: Jackfruit seed flour (150 gm), Soy flour (50 gm), Milk powder (20 gm), Sugar powder (20 gm), Cocoa powder (10 gm), Moisture (5-6%), (Fig.5).

3.4. Product analysis

3.4.1. Physical properties

Product yield per 100 gm of raw material was determined by measuring the weight of the extruded products and calculating the % yield per 100 gm. Dimension of the products were calculated by measuring the length and breadth of the products. The products were added in hot and cold milk and observed for 10-30 minutes to determine the stability.

3.4.2. Chemical Analysis

3.4.2.1. Proximate composition

The analysis of the samples for moisture, fiber and ash content were carried out in triplicate using standard methods. Carbohydrate was determined according to Anthrone reaction method and determination of protein was done by Folin Lowry method. Energy values were obtained using the Atwater formula where fat, protein, and carbohydrate supplied were 9, 4, 3.75 Kcal/g respectively.

3.4.2.2. Determination of Fat content

Fats were determined by Soxhlet method. Moisture free sample was weighed in moisture free thimbles and crude fat was extracted by refluxing in Soxhlet apparatus using n-hexane as solvent. The n-Hexane was distilled off and finally removed completely by applying vacuum. The weight of the recovered oil was taken.

Fat content (%) = Amount of fat extracted (g) x 100
Weight of original sample (g)

3.4.2.3. Mineral Analysis

Mineral of Extruded breakfast cereals was extracted according to Pearson's method (1981). Each sample was burnt in a muffle furnace at 550°C. Each sample was placed in a sand bath for 10 minutes after addition of 5 ml of 5 N HCl. Then the solution was carefully filtered in a 100 ml volumetric flask and finally distilled water was added to make up to mark. The extracts were stored in bottles for further analysis. Minerals Fe, Cu, Ca, Mg and Zn were determined using atomic absorption spectrophotometer (Model: GBC Avanta), (Fig.6). Potassium and sodium contents of each extracted sample were determined according to AOAC (1984) using Flame photometer (Model: Lawrence & Mayo 381).

Table 1 Temperature and Speed of Extruder

Temperature (°C)		Speed of the Extruder (rpm)	Speed of the cutter (rpm)
1st Heater	120	325	1200-1300
2nd Heater	80		
3rd Heater	60		

Table 2 Physical characteristics of Extruded breakfast cereal

S/N	PRODUCT CODE	Yield per 100gm raw material (gm)	Dimension (cm)		Stability of Extrudates	
			Length	Breadth	Hot milk	Cold milk
1.	EBCA	92	0.6	0.4	Stable	Stable
2.	EBCB	90	0.6	0.5	Stable	Stable
3.	EBCC	90	0.6	0.4	Stable	Stable
4.	EBCD	93	0.5	0.4	Stable	Stable

Table 3 Compositional comparison of Extruded Breakfast Cereals and Control

S/N	Proximate constituents (gm/100 gm)	CEBC*	EBCA	EBCB	EBCC	EBCD
1.	Moisture	6.2 ± 0.04^{a}	2.2 ± 0.05^{c}	2.1 ± 0.03^{d}	2.3 ± 0.04^{b}	2.0 ± 0.02^{e}
2.	Ash	2.4 ± 0.15^{d}	3.2 ± 0.03^{b}	3.2 ± 0.02^{b}	3.3 ± 0.05^{a}	3.1 ± 0.06^{c}
3.	Crude Fiber	2.1 ± 0.04^{c}	3.8 ± 0.05^{b}	3.8 ± 0.06^{b}	3.9 ± 0.06^{a}	3.8 ± 0.04^{b}
4.	Carbohydrate	$85.6\pm018.2.04^{a}$	70.6 ± 0.24^{b}	70.0 ± 0.19^{c}	68.3 ± 0.22^{e}	68.5 ± 0.20^{d}
5.	Protein	$8.0\pm0.0118.3^{e}$	18.2 ± 0.26^{d}	18.3 ± 0.28^{c}	20.0 ± 0.24^{a}	18.6 ± 0.26^{b}
6.	Fat	1.0 ± 0.01^{b}	0.7 ± 0.01^{d}	0.7 ± 0.02^{d}	0.8 ± 0.05^{c}	1.3 ± 0.03^{a}
7.	Energy (kcal)	363.5 ± 1.78^{a}	345.0 ± 1.40^{b}	343.2 ± 0.80^{e}	344.2 ± 0.98^{d}	344.3 ± 0.88^{c}

**CEBC: Control Extruded Breakfast Cereal*

Results are expressed as mean ± SD (n=3). Mean Values having different superscript letter in rows are significantly different ($p \leq 0.05$). Values having same superscript letter in columns are not significantly different ($p < 0.05$).

3.5. Sensory evaluation

A consumer is attracted by the positive attributes of the food product. So, the best quality product is most acceptable. The 4 sets of extruded breakfast cereals have been subjected to sensory evaluation test in order to identify the most desirable product for consumption. 10 members were chosen from the department of School of Community Science and Technology, BESU, Shibpur, Howrah, West Bengal. Evaluation was done on the basis of Nine Point Hedonic Scale rating (from 1 = extremely dislike to 9 = extremely like) was used to determine the preference in color, flavor, taste and overall acceptability. The consumers were instructed to first evaluate each sample by sniffing alone and then by tasting. The intensity of perceived odor was rated as flavor. Consumers rinsed their mouths with water after tasting each sample (Fig.7).

3.6. Statistical analysis

One-way ANOVA was used to compare the means of chemical composition data and sensory evaluation data determined for the group. Data were analyzed with Origin Pro 8 software. Results of analysis were calculated as mean ± standard deviation using the Tukey test and differences were considered significant at $p \leq 0.05$.

4. RESULTS AND DISCUSSION

4.1. Physical characteristics of Extruded breakfast cereal

Yield of products EBCA, EBCB, EBCC and EBCD were recorded to be 93%, 90%, 90% and 92% respectively. Dimension (length: breadth) of extruded products EBCA, EBCB, EBCC and EBCD were recorded to be 0.6cm: 0.4cm, 0.6cm: 0.5cm, 0.6cm: 0.4cm, 0.5cm:0.4cm respectively. When added to milk (both lukewarm and cold) all the products showed stability and remained floating (Table 2).

4.2. Moisture

Moisture contents (gm/100gm) were found 2.2±0.05, 2.1±0.03, 2.3±0.04 and 2.0±0.02 in EBCA, EBCB, EBCC and EBCD respectively (Table 3). EBCC contained the highest amount of moisture content followed by EBCA and EBCB where as EBCD contained the lowest amount of moisture. The control extruded breakfast cereal (CEBC) was found to contain much higher amount of moisture (6.2±0.04) as compared to the extruded breakfast cereals made.

4.3. Ash

Ash amounts (gm/100gm) were found 3.2±0.03, 3.2±0.02, 3.3±0.05 and 3.1±0.06 in EBCA, EBCB, EBCC and EBCD respectively (Table 3). The highest amount of ash was observed in EBCC, followed by EBCA and EBCB, and the lowest amount of ash was found in EBCD. The estimated ash values of the breakfast cereal are more than the control extruded breakfast cereal (2.4±0.15gm/100gm).

4.4. Crude fibre

Crude fibre amounts (gm/100gm) were found 3.8±0.05, 3.8±0.06, 3.9±0.06 and 3.8±0.04 in EBCA, EBCB, EBCC and EBCD respectively (Table 3). The highest content was observed in EBCC followed by EBCB, EBCA and EBCD. The findings ranged from 3.8 to 3.9, which were more or less similar; whereas the control extruded breakfast cereal contained 2.1±0.04 which is less than the estimated values.

4.5. Carbohydrate

Carbohydrate contents (gm/100gm) were found 70.6±0.24, 70.0±0.19, 68.3±0.22, and 68.5±0.20 in EBCA, EBCB, EBCC and EBCD respectively (Table 3). The highest carbohydrate content was observed in EBCA, followed by EBCB and EBCD, and EBCC contained the lowest amount of carbohydrate. The control extruded breakfast cereal contained 85.6±018.2.04 gm/100 of carbohydrate which is higher than the extruded breakfast cereals.

4.6. Protein

According to the above findings average content of protein of the extruded breakfast cereals varied from 18.20 to 20.00 (gm/100gm). Protein amounts were found 18.2±0.26, 18.3±0.28, 20.0±0.24 and 18.6±0.26 in EBCA, EBCB, EBCC and EBCD respectively (Table 3). The highest content of protein was found in EBCC, followed by EBCD and EBCB, and EBCA contained the lowest amount of protein. The control extruded breakfast cereal contained 8.0±0.0118.3gm/100 gm which is much lower as compared to the extruded breakfast cereals.

4.7. Fat

Fat contents (gm/100gm) were found 0.7±0.01, 0.7±0.02, 0.8±0.05 and 1.3±0.03 in EBCA, EBCB, EBCC and EBCD respectively (Table 3). The highest fat content was found in EBCD, followed by EBCC, EBCB and EBCA. The findings ranged from 0.70 to 1.30 gm/100gm of fat. The Control Extruded Breakfast Cereal contained 1.0±0.01 gm/100 gm of fat, which also lies within the range of the present findings.

Table 4 Mineral composition comparison of Extruded breakfast cereals and Control

S/N	MINERALS	CEBC*	EBCA	EBCB	EBCC	EBCD
1.	Sodium (mg/100gm)	900	63.84	60.26	61.71	63.34
2.	Potassium(mg/100gm)	-	974.35	988.76	982.85	972.89
3.	Iron(mg/100gm)	14	15.78	16.15	16.33	16.04
4.	Copper(mg/100gm)	-	0.89	0.98	0.95	0.84
5.	Zinc(mg/100gm)	2.5	2.23	1.992	1.935	2.31
6.	Calcium(mg/100gm)	130	157.58	160.76	160.35	158.76
7.	Magnesium(mg/100gm)	-	63.29	62.57	61.99	63.88

**CEBC: Control Extruded Breakfast Cereal*

Table 5 Sensory Evaluation of Extruded Product on the basis of 9 Point Hedonic Rating

S/N	Product Code	Colour	Taste	Aroma	Acceptability
1.	EBCA	5.9 ± 0.73^{c}	6.5 ± 0.52^{c}	7.6 ± 0.69^{c}	6.6 ± 0.84^{c}
2.	EBCB	5.0 ± 0.81^{d}	6.0 ± 0.66^{d}	7.0 ± 0.66^{d}	5.6 ± 0.84^{d}
3.	EBCC	6.8 ± 0.63^{b}	7.6 ± 0.51^{a}	7.8 ± 0.42^{b}	7.4 ± 0.51^{a}
4.	EBCD	7.4 ± 0.69^{a}	7.2 ± 0.63^{b}	8.2 ± 0.63^{a}	7.3 ± 0.67^{b}

Results are expressed as mean ± SD (n=10). Mean Values having different superscript letter in rows are significantly different (p≤0.05).

4.8. Energy

Energy values (kcal) of EBCA, EBCB, EBCC and EBCD were found to be 345.0±1.40, 343.2±0.80, 344.2±0.98 and 344.3±0.88 respectively (Table 3). The highest energy value was found in EBCA, Followed by EBCD and EBCC and EBCB contained the lowest energy value. The control extruded breakfast cereal contained 363.5±1.78 kcal of energy which is higher as compared to the Extruded breakfast cereals made.

4.9. Minerals

Sodium(Na) contents were found 63.84mg/100gm, 60.26mg/100gm, 61.71mg/100gm and 63.34mg/100gm in EBCA, EBCB, EBCC and EBCD respectively (Table 4). The Control Extruded Breakfast Cereal (CEBC) contained 900 mg/100gm of sodium which is much higher than the rest of the findings. Potassium (K) contents were found 974.35mg/100gm, 988.76mg/100gm, 982.85mg/100gm and 972.89mg/100gm in EBCA, EBCB, EBCC and EBCD respectively (Table 4);

whereas potassium content was not found to be present in CEBC. Iron (Fe) contents were found 15.78mg/100gm, 16.15mg/100gm, 16.33mg/100gm and 16.04mg/100gm in EBCA, EBCB, EBCC and EBCD respectively (Table 4). CEBC contained 14 mg/100gm of iron which is less as compared to the iron values of the extruded breakfast cereals. Copper (Cu) contents were found 0.89mg/100gm, 0.98mg/100gm, 0.95mg/100gm and 0.84mg/100gm in EBCA, EBCB, EBCC and EBCD respectively (Table 4). CEBC did not contain any amount of Copper. Zinc (Zn) contents were found 2.230mg/100gm, 1.992mg/100gm, 1.935mg/100gm and 2.31mg/100gm in EBCA, EBCB, EBCC and EBCD respectively (Table 4). The amount of zinc found in CEBC was 2.5 mg/100, which is a little bit more than the extruded breakfast cereals. Calcium (Ca) amounts were found 157.58mg/100gm, 160.76mg/100gm, 160.35mg/100gm and 158.76mg/100 gm in EBCA, EBCB, EBCC and EBCD respectively (Table 4); whereas a lesser amount of calcium (130 mg/100gm) was found in CEBC. Magnesium (Mg) contents were found 63.29mg/100gm, 62.57mg/100gm, 61.99mg/100gm and 63.88mg/100gm in EBCA, EBCB, EBCC and EBCD respectively (Table 4). CEBC contained negligible magnesium in it.

4.10. Sensory evaluation

Sensory evaluation of the products EBCA, EBCB and EBCD, indicated lesser acceptance in terms of taste and over all acceptability which means the products did not fetch much acceptability as compared to product EBCC. Product EBCA was reported to be slight bitter and bland in taste, it was lacking additional flavour, so flavour should be added to enhance over all acceptability. Product EBCB was reportedly found to be slight bitter which could be due to charring of excess sugar, it had chocolaty aroma. Product EBCD was rated better in terms of colour and aroma as compared to the rest of the breakfast cereals and product EBCC was rated best in terms of taste and overall acceptability (Table 5).

5. CONCLUSION

Jackfruit seeds are the valuable edible seeds that should not go waste in country like ours. The seed flour can be utilized in different kinds of food preparation. In the present work, attempts had been taken to utilize jackfruit seed flour along with de-fatted soy flour which is a protein rich material in formulation of four sets of extruded breakfast cereals. From the findings it is seen that Extruded Breakfast Cereal C (EBCC) among the four set of formulated products has the highest amount of Protein, Fiber and also fair amount of some important minerals, and also has been rated the best in terms of sensory evaluation. Therefore, it can be declared that Extruded breakfast Cereal C is the best and has the highest nutritive value as compared to the other breakfast cereals and the Control Extruded Breakfast Cereal.

SUMMARY OF RESEARCH

1. This work has provided information about utilization of jackfruit seed flour, which is a nutrient rich material in preparation of extruded breakfast cereals.
2. The present research resulted in formulation of protein rich breakfast cereal compared to the existing breakfast cereal in the market.

FUTURE ISSUES

Jackfruit seed flour can be commercially employed as it is nutritionally enriched. It can provide an opportunity to the food processing industries for preparation of nutrient rich food products.

DISCLOSURE STATEMENT

The authors would like to thank the INSPIRE PROGRAMME, DST, GOV. of INDIA for providing financial support.

ACKNOWLEDGEMENT

I acknowledge my thanks to my supervisor and guide and a special thanks to MITRA S.K. Pvt ltd (MSK PVT LTD) for their technical support.

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