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DEVELOPMENT AND EVALUATION OF MULTIGRAIN SNACK PREMIX INCORPORATED WITH JAMUN SEED POWDER

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ABSTRACT

In response to the rise in industrialization, the growing incidence of chronic diseases and changes in dietary habits, the present study was carried to develop and evaluate multigrain snack products incorporated with minor fruits at Department of Postharvest Management, College of Horticulture, Bagalkot, Karnataka during the year 2023-24. The study focused on developing and evaluating multigrain snack products incorporated with minor fruits. The products were assessed for their physico-chemical properties, sensory attributes and storage stability. Multigrain snack premix incorporated with jamun seed powder was prepared by varying jamun seed powder (1.00 to 5.00 g). The treatment T_6 (5.00 g of jamun seed powder) was found to be superior with WAC (3.16 g/g), WSI (7.48 %), SP (2.93 g/mL), SV (24.10 mL), BD (0.792 g/mL), color values (*L**: 81.37, *a**: 1.733 and *b**: 12.38), proximate composition (moisture: 11.47 g/100g, ash: 2.49 g/100g, protein: 15.00 g/100g, fat: 2.843 g/100g and fibre: 10.92 g/100g) and minerals (calcium: 152.80 mg/100g, magnesium: 154.30 mg/100g, iron: 4.943 mg/100g and zinc: 2.69 mg/100g).

Keywords : Multigrain, Jamun seed powder, Premix, Nutritional composition

Introduction

Jamun (*Syzygium cumini*) is an important fruit of the family Myrtaceae. It is considered to be indigenous to India and West Indies, being cultivated in the Philippines, West Indies and Africa. India is the second largest producer of the jamun fruit in the world. The seeds contain alkaloid, jambolin or antimellin, which halts the diastatic conversion of sugar to starch. The value-added products of the crop need to catch national and international focus so that its nutritional and therapeutic properties can be utilized in an ideal manner.

Multigrain composite mixes are processed from different cereals, legumes, millets, nuts along with condiments by different processes. This multigrain blend helps to mix different whole grains to maximize their nutritional, functional and sensory properties. Multigrain represent good source of carbohydrates, rich in dietary fibre, phenolic compounds and also minerals (Saturni *et al.*, 2010). These grains, apart from the macro nutrients, also form a good source of micronutrients and phytochemicals.

With the current eating habits, there is a noticeable trend of consuming junk food and empty calorie snacks, which contribute to various health issues such as obesity and metabolic syndrome. Therefore, it is crucial to develop healthy and nutritious snack premix to replace these empty calorie

foods. The present study aims to standardize innovative snacks premix by incorporating dried powders of jamun seed with multigrain to promote functional snack mixes.

Materials and Methods

Procurement of raw material

The jamun fruits and ingredients for the multigrain premix such as wheat, finger millet, green gram, soybean and chia seeds were purchased from the local market.

Development of multigrain sprouts

Multigrain such as wheat, finger millet, green gram, soybean and chia seeds were soaked in water for 12 hours. After washing, they were placed in a dark area with a tightly tied cloth to sprout for 2 days at room temperature. Following the sprouting process, they were sun-dried and ground into a fine powder.

Preparation of jamun seed powder

Jamun fruits were washed and depulped. The seeds were then washed, dried in a solar tunnel drier, ground and sieved to obtain a fine powder.

Physical properties of multigrain premix

The physical properties such as water absorption capacity was determined using the method of Abbey and Ibeh (1988), Water solubility index was determined by using the Kainuma *et al*. (1967) method, swelling power was determined using the Leach *et al*. (1959) method, sedimentation volume was measured by the method of Preethi (2013), bulk density was determined by using method of Seifu *et al*. (2018), Particle size was assessed through size distribution by intensity at Centre for Nanotechnology, UAS, Raichur, Karnataka.

Table 1: Multigrain premix incorporated with jamun seed powder

Ingredients	T_1	T_2	T_3	T_4	T_5	T_6
Whole wheat flour (g)	100.00	64.00	63.00	62.00	61.00	60.00
Chia seeds flour (g)	-	10.00	10.00	10.00	10.00	10.00
Green gram flour (g)	-	10.00	10.00	10.00	10.00	10.00
Finger millet (g)	-	10.00	10.00	10.00	10.00	10.00
Defatted soya flour (g)	-	5.00	5.00	5.00	5.00	5.00
Jamun seed powder (g)	-	1.00	2.00	3.00	4.00	5.00

Proximate composition of multigrain premix

Nutritional composition of dehydrated BLP as well as *khakhra* were analysed as per standard procedure. The proximate composition such as moisture was measured using a Radwag moisture analyzer (Model: MAC 50, Make Poland), crude protein by using Micro Kjeldahl method, crude fat by using automatic Soxhlet apparatus (Model: SOCS PLUS; Pelican Equipments, Chennai) by following the method of Ojure and Quadri (2012), crude fiber performed using the Fibra Plus-FES-6 instrument, ash by using a muffle furnace, carbohydrates were estimated as per AOAC (1980), Calorific value was determined by differential method (BeMiller, 2017).

Minerals

Mineral's content of multigrain snack premix incorporated with jamun seed powder such as calcium and magnesium content were measured using the complexometric titration method as described by Jackson (1973), the iron and zinc were determined according to Lindsay and Norvell, (1978) by atomic absorption spectrophotometer.

Statistical analysis

Completely Randomized Design (CRD) with one-way ANOVA, utilizing the Web Agri Stat Package (WASP) version 2 (Jangam and Thali, 2010) was used to examine the data on the physico-chemical properties

of multigrain snack premix incorporated with jamun seed powder. p=0.01 was the significance level applied to the tests. The tests used a significance level of p=0.01. Critical difference values were calculated when the F-test indicated significance.

Result and Discussion

Physical properties of multigrain premix

Water absorption capacity (g/g)

The data revealed the significant difference among the treatments with respect to water absorption capacity (Table 2). The water absorption capacity (WAC) was ranged from 3.15 to 3.25 g/g with a mean of 3.19 g/g. However, highest WAC was found in T_2 with 3.25 g/g which was followed by T_3 with 3.22 g/g. Whereas, the lowest WAC was found in T_1 with 3.15 g/g. WAC is a critical function of protein, which is known to imbibe water without dissolution of protein, thereby attaining body thickening and viscosity (Kumar *et al*., 2016). However, there was decrease in WAC value with increase in concentration of jamun seed powder which is due to decrease in protein content. Similar trend was followed in investigation carried out by Vijayakumar and Mohankumar (2009) who studied WAC of the multigrain premix. The results are in accordance with Shinde *et al*. (2017).

Water solubility index (%)

Table 2 depicts the water solubility index of multigrain snack premix incorporated with jamun seed powder. Water solubility index (WSI) ranged from 4.78 to 8.05 per cent. The maximum WSI was observed in T_2 with 8.05 per cent followed by T_3 with 7.91 per cent and minimum WSI was found in T_1 with 4.78 per cent. Proteins are globular with high number of hydrophilic residues and buried hydrophobic and cysteine groups resulting in aqueous solubility, due to this high WSI was observed in T_2. However, there was decrease in WSI with increase in incorporation of jamun seed powder because of decrease in protein content. The results are similar to the research carried by Kumar *et al*. (2016) where they have studied WSI of multigrain premix

Swelling power (g/mL)

The results pertaining to swelling power showed significant difference among the treatments (Table 2). Swelling power ranged from 1.23 to 3.10 g/mL. The significant highest swelling power was observed in T_2 with 3.10 g/mL followed by T_3 with 3.06 g/mL and lowest swelling power was seen in T_1 with 1.23 g/mL. However, there was decrease in swelling index with increase in jamun seed powder incorporation due to decrease in protein content which absorbs water and swell. As protein content is decreased, it results in decrease of swelling index. Similar trend was observed in findings of Vijayakumar and Mohankumar (2009) who inferred the decrease in swelling index of the multigrain premix.

Sedimentation volume (mL)

The data pertaining to sedimentation volume of multigrain snack premix incorporated with jamun seed powder is represented in Table 2, ranging from 24.10 to 37.50 mL. The increasing trend in the sedimentation volume was observed in control (T_1) followed by T_2 with 30.70 mL. The decline in sedimentation volume was recorded in T_6 with 24.10 mL. The decrease in sedimentation volume with increasing incorporation of jamun seed powder is due to decreased level of wheat flour which reduced gluten protein responsible for absorbing water and leading to sedimentation. The results were in parallel with Vijayakumar and Mohankumar (2009) where sedimentation volume decreased with decrease in incorporation of wheat flour in composite flour.

Bulk density (g/mL)

Table 2 depicts the bulk density (BD) of the multigrain snack premix incorporated with jamun seed powder. The mean value of BD was recorded 0.804 g/mL. However, multigrain snack premix varied from 0.792 to 0.850 g/mL. The increased trend of bulk density was noticed in T_1 however, it declined in T_6 which was on par with all other treatments. The decrease in BD is due to decreased concentration of wheat flour which has finer particles contributing to the higher BD whereas jamun seed powder has coarse particles resulting in low bulk density of T_6 treatment. Investigation carried out by Kumar *et al*. (2016) have the same results explaining the influence of fine particles affecting the bulk density of multigrain premix.

Particle size (d.nm)

The data pertaining to particle size of multigrain snack premix incorporated with jamun seed powder is represented in Table 2. The significant difference among the treatments was ranging from 292.80 to 405.00 d.nm. However, the highest particle size was found in T_6 (60.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 5.00 g of JSP - 405.00 d.nm) followed by T_5 (61.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 4.00 g JSP - 384.40 d.nm) and lowest particle size was found in T_1 (100.00 g WF - 292.80 d.nm). There was significant increase in particle size with decrease in wheat flour because of finest particle present in wheat flour and due to the multigrain

premixes having larger particles compared to wheat flour.

Colour value (*L, *a** and *b**)**

The data representing colour values (*L**, *a** and *b**) of multigrain snack premix incorporated with jamun seed powder is illustrated in Table 3.

***L** value**

The physical properties of product presented in Table 3, indicate that, the product was cream coloured with lightness value which varied from 81.37 to 85.79 with a mean value of 82.45. The significant maximum value of *L** was recorded in T_1 with 85.79 followed by T_2 with 82.26 and lowest was recorded in T_6 with 81.37. The decreasing trend of *L** value may be due to incorporation of finger millet flour, chia seed flour and jamun seed powder

***a** value**

The redness value of multigrain snack premix incorporated with jamun seed powder varied from 1.533 to 1.733. The significant high redness value was found in T_6 with 1.733 which was on par with T_5 with 1.728. However, the least was found in T_1 with 1.533. There was significant increase in *a** value with increase in jamun seed powder because of redness imparted by jamun seed powder.

***b** value**

The yellowness (*b**) value of the product was ranging from 11.27 to 12.38. The highest *b** value was found in T_6 followed by T_5 and lowest was found in T_1. The increasing trend of *b** is due to increase in incorporation of jamun seed powder. The similar results were found in findings of Goyat *et al*. (2019) where addition of quinoa seeds decreased *L**, increased *a** and *b** value of porridge premix.

Proximate composition of multigrain premix

Moisture (g/100 g)

The moisture content of multigrain snack premix incorporated with jamun seed powder was ranged from 11.47 to 14.32 g/100 g (Table4). However, the significant maximum moisture content was found in T_1 with 14.32 g/100 g followed by T_2 with 11.87 g/100 g and the significant lowest moisture content was found in T_6 with 11.47 g/100 g. The significant decrease in moisture content is due to decrease in water absorption capacity of the jamun seed powder compared to wheat flour. Negi *et al*. (2021) reported that incorporation of apple pomace powder to the muffin premix reduced the moisture content

Ash (g/100 g)

The analysis revealed that, the treatments with respect to ash content of multigrain snack premix incorporated with jamun seed powder varied significantly (Table 4). The ash content varied from 1.50 to 2.49 g/100 g. However highest ash content was noticed in T_6 with 2.49 g/100 g which is on par with T_5 with 2.46 g/100 g and lowest ash content was noticed in T_1 with 1.50 g/100 g. The increasing trend of ash content might be due to the incorporation of jamun seed powder which are rich source of minerals. Similar results were found in the investigation of Negi *et al*. (2021) where ash content increased with incorporation of apple pomace to the muffin premix. Palamthodi *et al*. (2021) reported that with addition of jackfruit seed powder to the composite flour increased ash content.

Protein (g/100 g)

Table 4 depicts the protein content of multigrain snack premix incorporated with jamun seed powder. The protein content varied from 11.82 to 15.29 g/100 g. However maximum protein content was found in T_2 with 15.29 g/100 g followed by T_3 with 15.23 g/100 g and least was found in T_1 with 11.82 g/100 g. The increase in protein in T_2 is due to combined effect of multigrain. However, Protein content decreased with increase in jamun seed powder, this is due to low protein content of jamun seed powder compared to wheat flour. The results are similar to the investigation of Negi *et al*. (2021) where protein content decreased with addition of apple pomace powder to muffin premix. In another case study by Sukhwal and Vyas (2015) found that addition of amla powder to the premix decreased the protein content.

Fat (g/100 g)

The data illustrating the fat content of multigrain snack premix incorporated with jamun seed powder is represented in Table 4. The fat content ranged from 1.720 to 2.852 g/100 g. However highest fat content was found in T_2 with 2.852 g/100 g which was in on par with subsequent treatments incorporated with jamun seed powder and the lowest fat content was recorded in T_1 with 1.720 g/100 g. The increase in fat content in T_2 compared to T_1 is may be due to the increased fat content of other multigrain such as finger millet flour and chia seed flour which has high fat content compared to wheat flour. Similar trend observed in investigation of Rekha *et al*. (2019) where fat content reduced with addition of other multigrain such as finger millet, amaranth and oats when compared to control that is sorghum.

Fibre (g/100 g)

The fibre content of multigrain snack premix incorporated with jamun seed powder is presented in Table 4 which was ranged from 10.92 to 12.90 g/100 g. The highest fibre content was noticed in T_1 and the least fibre content was found in T_6 which was in on par with other treatments. The decrease in fibre content with incorporation of jamun seed powder is due to less fibre content in jamun seed powder compared to wheat flour. The investigation of Hussain (2018) showed that with addition of apricot powders, there was decrease in fibre content in porridge mixes.

Carbohydrate (g/100 g)

The data in Table 5 depicts the carbohydrate content of multigrain snack premix incorporated with jamun seed powder. The carbohydrate value ranged from 56.21 to 57.74 g/100 g. The highest carbohydrate content was recorded in T_1 followed by T_6 and the least was found in T_2. There was decrease in carbohydrate content in T_2 compared to control due to the multigrain premix which is rich in ash, protein and fat content compared to wheat flour (T_1). However, there was increase in carbohydrate content with increase in jamun seed powder concentration due to decrease in ash, protein and fat content in jamun seed powder. The results are also similar to the investigation done by Naveena *et al*. (2024) where by addition of watermelon seed powder to nutri-mix increased carbohydrate content.

Energy (kcal/ 100 g)

The data related to the energy value in the multigrain snack premix incorporated with jamun seed powder is presented in Table 5. The calorific value of the snack premix ranged between 293.72 - 314.71 kcal/100 g. The highest level of energy value was recorded in T_6 with 314.71 kcal/100 g followed by T_5 with 314.01 kcal/100 g, whereas lowest content was recorded in T_1 with 293.72 kcal/100 g. Current research finding showed increase in energy value with increase in incorporation of jamun seed powder due to increase in carbohydrate level.

Minerals (calcium, magnesium, iron and zinc)

Calcium (mg/100 g)

The data presented in Table 6 describes the mineral composition of the various treatments used in the preparation of multigrain snack premix incorporated with jamun seed powder. The lowest calcium content was found in T_1 (100.00 g WF - 41.04 mg/ 100g) whereas, highest was found in T_6 followed by T_5 and T_4.

Magnesium (mg/100 g)

The data pertaining to magnesium content in multigrain snack premix incorporated with jamun seed powder is represented in Table 6. The mean value for magnesium content in the developed product ranged from 120.03 to 154.63 mg/100 g. However, highest magnesium content was found in T_2 with 154.63 mg/100g followed by T_3 with 154.55 mg/100g and lowest was found in T_1 with 120.03 mg/100g.

Iron (mg/100 g)

The data illustrating the iron content in multigrain snack premix incorporated with jamun seed powder is presented in Table 6. The iron content in premix ranged from 3.920 to 4.943 mg/100 g. The significant maximum iron content was found in and the significant minimum iron content was recorded in T_1.

Zinc (mg/100 g)

The data pertaining to the zinc content of multigrain snack premix incorporated with jamun seed powder is illustrated in Table 6. The zinc value was ranged from 2.58 to 2.77 mg/100 g. The maximum zinc content was found in T_2 which was on par with T_3 and least was found in T_1.

Calcium and iron content increased with increase in jamun seed powder, this is due to jamun seed powder rich in calcium and iron content compared to wheat flour. Whereas, the magnesium and zinc content decline with increase in jamun seed powder in subsequent treatments this may be due to the wheat flour alone contains higher magnesium and zinc content. The results are close with the data presented by Borbi *et al*. (2020) where incorporation of banana powder increased mineral value in porridge mix. This study is in parallel to the findings of Goyat *et al*. (2019) where addition of quinoa seeds increased mineral content in porridge premix.

Table 2: Effect of treatments on physical parameters of multigrain snack premix incorporated with jamun seed powder

Treatment	Physical parameters					
	Water absorption capacity (g/g)	**Water solubility index (%)**	**Swelling power (g/mL)**	**Sedimentation volume (mL)**	**Bulk density (g/mL)**	**Particle size (d.nm)**
T_1: 100.00 g WF	3.15 ^{e}	4.78 ^{f}	1.23 ^{f}	37.50 ^{a}	0.850 ^{a}	292.80 ^{f}
T_2: 64.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 1.00 g JSP	3.25 ^{a}	8.05 ^{a}	3.10 ^{a}	30.70 ^{b}	0.797 ^{b}	295.50 ^{e}
T_3: 63.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 2.00 g JSP	3.22 ^{b}	7.91 ^{b}	3.06 ^{b}	28.80 ^{c}	0.796 ^{b}	340.30 ^{d}
T_4: 62.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 3.00 g JSP	3.20 ^{c}	7.77 ^{c}	3.01 ^{c}	27.60 ^{d}	0.794 ^{b}	348.50 ^{c}
T_5: 61.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 4.00 g JSP	3.18 ^{d}	7.63 ^{d}	2.97 ^{d}	25.40 ^{e}	0.793 ^{b}	384.40 ^{b}
T_6: 60.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 5.00 g JSP	3.16 ^{e}	7.48 ^{e}	2.93 ^{e}	24.10 ^{f}	0.792 ^{b}	405.00 ^{a}
Mean	**3.19**	**7.27**	**2.72**	**29.02**	**0.804**	**344.42**
S.Em±	0.004	0.005	0.004	0.089	0.004	0.382
C.D. at 1%	0.016	0.022	0.016	0.364	0.015	1.555

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour JSP: Jamun seed powder GGF: Green gram flour
FMF: Finger millet flour CSF: Chia seed flour DSF: Defatted soya flour

Table 3: Effect of treatments on colour (L^*, a^* and b^*) values of multigrain snack premix incorporated with jamun seed powder

Treatment	***L****	***a****	***b****
T_1: 100.00 g WF	85.79 ^{a}	1.533 ^{d}	11.27 ^{f}
T_2: 64.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 1.00 g JSP	82.26 ^{b}	1.540 ^{d}	11.62 ^{e}
T_3: 63.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 2.00 g JSP	82.15 ^{c}	1.633 ^{c}	11.79 ^{d}
T_4: 62.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 3.00 g JSP	81.64 ^{d}	1.658 ^{b}	11.92 ^{c}
T_5: 61.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 4.00 g JSP	81.48 ^{e}	1.728 ^{a}	12.05 ^{b}
T_6: 60.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 5.00 g JSP	81.37 ^{f}	1.733 ^{a}	12.38 ^{a}
Mean	**82.45**	**1.637**	**11.84**
S.Em±	0.013	0.006	0.007
C.D. at 1%	0.054	0.022	0.028

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour JSP: Jamun seed powder GGF: Green gram flour
FMF: Finger millet flour CSF: Chia seed flour DSF: Defatted soya flour

Table 4: Effect of treatments on proximate composition of multigrain snack premix incorporated with jamun seed powder

Treatment	**Moisture (g/100g)**	**Ash (g/100g)**	**Protein (g/100g)**	**Fat (g/100g)**	**Fiber (g/100g)**
T_1: 100.00 g WF	14.32 ^{a}	1.50 ^{d}	11.82 ^{f}	1.720 ^{b}	12.90 ^{a}
T_2: 64.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 1.00 g JSP	11.87 ^{b}	2.40 ^{c}	15.29 ^{a}	2.852 ^{a}	11.38 ^{b}
T_3: 63.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 2.00 g JSP	11.75 ^{c}	2.42 ^{c}	15.23 ^{b}	2.850 ^{a}	11.27 ^{bc}
T_4: 62.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 3.00 g JSP	11.66 ^{d}	2.43 ^{bc}	15.15 ^{c}	2.848 ^{a}	11.15 ^{cd}
T_5: 61.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 4.00 g JSP	11.56 ^{e}	2.46 ^{ab}	15.07 ^{d}	2.846 ^{a}	11.03 ^{de}
T_6: 60.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 5.00 g JSP	11.47 ^{f}	2.49 ^{a}	15.00 ^{e}	2.843 ^{a}	10.92 ^{e}
Mean	**12.11**	**2.28**	**14.59**	**2.660**	**11.44**
S.Em±	0.009	0.008	0.007	0.004	0.038
C.D. at 1%	0.037	0.031	0.030	0.016	0.156

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour JSP: Jamun seed powder GGF: Green gram flour
FMF: Finger millet flour CSF: Chia seed flour DSF: Defatted soya flour

Table 5: Effect of treatments on carbohydrate and energy value of multigrain snack premix incorporated with jamun seed powder

Treatment	Carbohydrate (g/100g)	Energy (kcal/100g)
T_1: 100.00 g WF	57.74 [a]	293.72 [f]
T_2: 64.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 1.00 g JSP	56.21 [f]	311.66 [e]
T_3: 63.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 2.00 g JSP	56.49 [e]	312.51 [d]
T_4: 62.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 3.00 g JSP	56.76 [d]	313.28 [c]
T_5: 61.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 4.00 g JSP	57.03 [c]	314.01 [b]
T_6: 60.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 5.00 g JSP	57.28 [b]	314.71 [a]
Mean	**56.92**	**309.99**
S.Em±	0.009	0.009
C.D. at 1%	0.037	0.037

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour JSP: Jamun seed powder GGF: Green gram flour
FMF: Finger millet flour CSF: Chia seed flour DSF: Defatted soya flour

Table 6: Effect of treatments on mineral content of multigrain snack premix incorporated with jamun seed powder

Treatment	Calcium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)
T_1: 100.00 g WF	41.04 [f]	120.03 [f]	3.920 [b]	2.58 [d]
T_2: 64.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 1.00 g JSP	149.01 [e]	154.63 [a]	4.931 [a]	2.77 [a]
T_3: 63.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 2.00 g JSP	149.95 [d]	154.55 [b]	4.934 [a]	2.76 [a]
T_4: 62.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 3.00 g JSP	150.90 [c]	154.46 [c]	4.936 [a]	2.73 [ab]
T_5: 61.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 4.00 g JSP	151.85 [b]	154.38 [d]	4.940 [a]	2.71 [bc]
T_6: 60.00 g WF + 10.00 g CSF, GGF, FMF + 5.00 g DSF + 5.00 g JSP	152.80 [a]	154.30 [e]	4.943 [a]	2.69 [c]
Mean	**132.59**	**148.72**	**4.77**	**2.71**
S.Em±	0.010	0.046	0.004	0.009
C.D. at 1%	0.039	0.187	0.016	0.037

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour JSP: Jamun seed powder GGF: Green gram flour
FMF: Finger millet flour CSF: Chia seed flour DSF: Defatted soya flour

Conclusion

From the present study, it would be concluded that minor fruits such as jamun seed along with multigrain incorporation has enriched the nutritional value of the developed premix. The best optimization level found for multigrain snack premix incorporated with jamun seed powder was treatment T_6 (60.00 g WF+ 5.00 g JSP + 10.00 g CSF, 10.00 g GGF 10.00 g FMF and 5.00 g DSF).

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