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Process Optimisation For The Preparation Of Ready To Cook Maize Based Porridge Mix

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Abstract

With change in lifestyle pattern and due to excessively busy schedules, people have been shifting to more of a convenient way of obtaining nutrition, such as the food which is ready-to-cook, ready-to-eat or ready-to-serve. Ready-to-cook foods are the food which requires minimal preparation time and provides adequate nutrition. In this study, ready-to-cook cereal based porridge mix was prepared in which maize (*Zea mays* L.) was used as a cereal base. Maize grits were incorporated in different concentrations (10, 20, 30, 40, 50, 60 and 70%). Physical properties including bulk density, water absorption capacity and oil absorption capacity, antioxidant activity including free radical scavenging activity and ferric reducing antioxidant power, antioxidant content including ascorbic acid content, carotenoid content, total phenols and total flavonoid content were determined. Treatment with maize grit concentration of 70% showed the highest value of free radical scavenging activity (38.6±1.3%) and Ferric ion reducing power activity (232.99±2.17 µmol Fe(II)/g). Ascorbic acid, flavonoid content and total phenolic content decreased significantly ($p<0.05$) with the increase in the concentration of maize grits, while increase carotenoid content was observed among the treatments. Sensory analysis of the cooked produce of these treatments was performed by using 9-point hedonic scale which revealed that the most acceptable treatment was 60%. Proximate analysis of this treatment was evaluated which showed that it contained about 15.09±0.89% of protein, 1.49±0.71% fat, 3.09±0.84% fiber and 1.53±0.90% ash.

Keywords: Instant maize porridge, antioxidant, sensory analysis, grits

Introduction

A wide variety of instant processed foods are accessible in the market serving as functional foods providing both convenience as well as health benefits (Singh *et al.*, 2013). Breakfast cereals have high content of dietary fibres (Mandge *et al.*, 2011), fructans and other health promoting bioactive compounds such as phenolic compounds (Benitez *et al.*, 2018) and flavonoid compounds (Moreno *et al.*, 2017) which makes it a nutritious food. Coarse cereal grains, referred to the grains which are used mainly as a fodder crop or for brewing, are termed as nutricereals due to their enhanced nutritional value. These grains includes pearl millet, sorghum, maize, oat (*Avenasativa*), barley (*Hordeum vulgure*), finger millet (*Eleusinecoracana*), foxtail millet (*Setaria italic*) etc. The production of these grains is on larger scale in tropical regions of Asia and Africa (Singh et al., 2013). These cereals are good sources of minerals like iron, copper, selenium, magnesium, zinc, manganese, phosphorous and selenium; essential vitamins such as thiamine, riboflavin, niacin, folate, vitamin A, vitamin E and vitamin B_6; protein, carbohydrates, dietary fibres and some bioactive compounds like phenols which provides us with numerous health promoting properties such as increased resistance for diseases and some immunomodulatory effects (Kaur et al., 2012).

Porridge is milk and cereal-based heat desiccated dairy product which is made by cooking cereal grits in boiling water or milk and sugar to sweeten the product (Jha & Patel et al., 2012; Jha et al., 2012). Due to rapid urbanization in the developing countries, the convenience food which are ready to eat have been developed in varieties such as kheer ready mix, instant porridge mix etc. Corn or maize belongs to the family of Poacaea and scientifically known as *Zea mays L.* (Kumar & Jhariya, 2013). It is the third most consumed cereal grain in the world after rice and wheat. Although many works were undertaken

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Vol-22- Issue-12-November-2019

regarding incorporation of corn kernels in different food products, none has been used them in the instant porridge mix formulation. Thus, this research was undertaken to develop new product by incorporating corn kernels in different concentrations.

Materials and Methods

Corn grit preparation

The corn kernels were processed as shown in Figure 1 and stored in a sealed polythene bag (Wellworth Packers Pvt. Ltd., Delhi, India) for further use.

Preparation of instant mix

To prepare maize based instant mix, different blends were prepared first in which different ratios of corn grits and milk powder were taken keeping sugar content constant i.e. 20%. The treatments prepared are shown in Table 1.

Physical Properties

Bulk density was calculated by the method given by AOAC, 2005 water absorption capacity and oil absorption capacity was calculated by the method given by Singh et al., 2018.

Determination of antioxidant content

The total phenolic content of varieties was calculated using the Folin-Ciocalteau method described by Zaouay et. al., (2012) and the values were calculated as mg of gallic acid equivalents (GAE) per 100g of dry matter. Total flavonoid content was evaluated by a calorimetric assay described by Nawaz et al., (2013) and the values were recorded as mg of catechin equivalents (CE) per 100g of dry matter. The ascorbic acid content was determined using standard 2,6-dichloroindophenol titrimetric method according to AOAC (2005). It is expressed as mg per 100g on fresh weight basis.

ISSN:0971-1260
Vol-22- Issue-12-November-2019

Carotenoid

Carotenoid content was determined following the method given by Zilic et al., (2011). The results were calculated as mg per 100g dry matter.

Determination of Antioxidant activity

Free Radical Scavenging Activity (FRSA)

The assay was measured based on the ability of the antioxidant from the sample to inhibit the 2,2-diphenyl-1-picrylhydrazyl or DPPH free radicals as given by Nile et. al., (2014). To 3.9 ml of $6x10^{-5}$mol/L DPPH, a known sample (0.1 ml) extract was added and allowed to stand for 30 minutes. The optical density was recorded at 515 nm and the activity was calculated using equation;

Antioxidant activity (%) = $\frac{A_{\circ} - A}{A_{\circ}}$

where, $A_{\circ}$ is absorbance of blank; A is absorbance of sample.

Ferric reducing antioxidant power (FRAP)

Ferric reducing antioxidant power was determined following method given by Singh et al., (2016). Stock solution was prepared including 300mM acetate buffer (pH 3.6), 10mM TPTZ solution in 40mM HCl and 20mM ferric chloride hexahydrate in a ratio of 10:1:1. 2.85ml of freshly prepared FRAP solution was taken and 150µl of sample extract was added to it and allowed to stand for 30 minutes at 37°C. The absorbance was recorded at 593 nm and results were expressed as mM of Fe(II) per gram of dry matter.

Sensory analysis

Porridge samples were cooked in hot water. The sensory tests of the porridge were performed with an evaluation panel of 25 members (age ranges 20-40 years). All the Information

ISSN:0971-1260
Vol-22- Issue-12-November-2019

regarding the nature of the evaluation was given to panelist beforehand. All porridge samples (with 10, 20, 30, 40, 50, 60 and 70% of corn grits) were evaluated in one session on one day. Panelists received one sample at a time with a two minutes break between samples. The panelist were asked to score the cooked porridge in terms of colour, flavor, consistency, mouthfeel and overall acceptability using a 9-point hedonic scale (Jha et al., 2015).

Determination of nutritional composition

The nutritional composition of the most acceptable instant mix porridge sample was determined for moisture, carbohydrates, protein, fat, ash and total fiber content were calculated using standard procedures given by AOAC (2005).

Statistical analysis

The means and standard deviations were determined for all the physical, antioxidant content, antioxidant activity and sensory qualities. One way analysis of variance (ANOVA) followed by LSD test and Duncan's test using SPSS software at a significance level of ($p < 0.05$) was used to check the significant difference of the mean values.

Results and discussion

Physical properties

The data regarding the physical properties of the treatments is given in the Table 2. Increase in the bulk density was observed as the concentration of the corn grits increased. It ranged from 1.21±0.08 g/cm^3 in 10% treatment to 1.45±0.07 g/cm^3 in 70% treatment. Although, the decrease in bulk density is desirable for transportation and packaging cost, the results showed were not that high for bulk density. The results were in agreement with Awoyale et al., (2011) for the bulk density of maize based snack substituted with distillers spent grain. They reported that bulk density reduced as the maize flour were replaced by distillers spent grain from 72% for 100% maize flour to 62% for the blend which shows that the maize flour

ISSN:0971-1260
Vol-22- Issue-12-November-2019

incorporation increases the bulk density and this might be due to change in the protein content.

Water absorption capacity is the important parameter for the production of ready to eat foods and high absorption capacity helps in product cohesiveness (Thara & Nazni 2018). There was a significant ($p<0.05$) increase in the water absorption capacity as the concentration of corn grits increased. It ranged from 36.06±0.89% in 10% treatment to 132.01±0.98% in 70% treatment. Similar results were reported by Onuegbu et al., 2013 where the substitution of maize flour for the development of bread reported the increase in water absorption capacity from 2.05g/g for the 100% wheat flour to 2.52g/g at 20% maize flour addition. The oil absorption capacity varies due to change in protein concentration, conformational changes and degree of interaction with water and oil (Butt, 2010). The oil absorption significantly increased ($p<0.05$) with increase in the concentration of the corn grits. It ranged between 93.06±0.89% in 10% treatment to 111.05±0.95% in 70% treatment. The results were in accordance with Onuegbu et al., 2013 for the preparation of bread and cake supplemented with maize flour.

Antioxidant Activity

The antioxidant activity determined by DPPH assay was found to be significantly ($p<0.05$) increasing with the increasing concentration of corn grits. It ranged between 16.43±1.87% in 10% treatment to 38.6±1.3% in 70% treatment. The antioxidant activity determined by FRAP assay increased as the concentration of corn grits increased. It ranged between 198.11±1.86 µmol Fe (II)/g of DW in 10% treatment to 232.99±2.17µmol Fe (II)/g of DW in 70% treatment. The values are shown in Figure 2 and Figure 3, respectively. Similar results have been reported by Song et al., (2013) where they evaluated the effect of different cooking methods on bioactive properties of fresh and frozen sweet corn. It was found that after being

ISSN:0971-1260
Vol-22- Issue-12-November-2019

cooked for 1, 3, and 5 minutes, the extract of fresh corn retained about 73.5, 75.5 and 78.5% of total antioxidant activity, respectively, which is higher than that of the fresh sweet corn extracts (64.4%). Harakotr et al., (2014) also reported that steam cooking the corn preserved greater content of antioxidant as compared to boiling. These results may suggest that more the preserved antioxidants, the more will be the radical scavenging rate.

Antioxidant content

The data shown in Table 3 depicts that the total phenol content significantly decreased ($p<0.05$) from corn grit concentration of 10% to 70%. It ranged between 48.31±0.68 mg GAE/100g dw in 10% treatment to 26.97±0.98 mg GAE/100g dw in 70% treatment. In the study by Harakotr et al., (2014) concluded that phenols being soluble in water, undergo large losses in the cooking water, resulting in the decreased phenolic content as compared to the raw corn. The flavonoids content was analysed and the result showed that it increased with the increase in the concentration of corn grits. It ranged between 83.36±0.91 mg CE/100g dw in 10% treatment and 127.61±0.74 mg CE/100g dw in 70% treatment. Similar findings were obtained in a study by Oboh et. al. (2010) as the extractable flavonoid content reduces on thermal treatment.

The ascorbic acid content was found to be decreasing with the increase in corn grits concentration. It ranged from 208.26±0.87mg/100g in 10% treatment to 104.06±0.12mg/100mg in 70% treatment. A study by Brennan et al., (2011) reported that the ascorbic acid content degrades on thermal treatment. The values obtained were in accordance with the findings of Olapade et al., (2014) where the ascorbic acid content decreased with the increased incorporation of maize flour in the product.

A difference at significant level ($p<0.05$) in carotenoid content was found among the treatments. It increased, ranging from 800.18±1.29 in 10% treatment to 3850.10±1.05

ISSN:0971-1260
Vol-22- Issue-12-November-2019

µg/100ml in 70% treatment. A similar trend was observed by Song et al., (2013) for carotenoid content of corn which increased by 1.1 to 1.8 times when it was steam cooked as the availability of total carotenoids is enhanced on thermal treatment.

Sensory analysis

The instant porridge were prepared by mixing it in boiling water (1:4) as shown in Figure 4. 25 panelists of age 25-44 years were chosen who were free from any disease and the 9-point hedonic scale was used to evaluate the product (10, 20, 30, 40, 50, 60 and 70% concentration). The result as mentioned in Table 4 showed that the treatment with 60% corn grits was most acceptable with highest score of mouth-feel about 7.80±0.92, consistency about 7.55±0.82, flavor about 7.95±0.97, colour about 7.55±0.67 and overall acceptability of 7.65±0.71.

Proximate analysis

From the results of physical properties, bioactive properties and sensory analysis, it can be concluded that the most acceptable treatment is 60%. The proximate analysis for the treatment (60%) is given in the Table 5.

Conclusion

The treatments were prepared with different concentration of corn grits showed significant increase in the bulk density with the increase in concentration of the grits. The water absorption capacity and oil absorption capacity increased significantly ($p<0.05$) with the increased corn grits concentration. The carotenoid content significantly increased ($p<0.05$)

ISSN:0971-1260
Vol-22- Issue-12-November-2019

however, total flavonoids, ascorbic acid and total phenolic content significantly decreased ($p<0.05$) from 10 to 70% incorporation of corn grits. The sensory analysis showed that 60% incorporation gains the high overall acceptability that shows that the highest limit for the addition of maize grits.

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ISSN:0971-1260
Vol-22- Issue-12-November-2019

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ISSN:0971-1260
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ISSN:0971-1260
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Soak the corn kernels for 2 hours in water (1:3)

↓

Steam the kernels for 15 minutes at 121 °C

↓

Tray dry the kernels at 60°C for 8-9 hrs

↓

Mill the kernels to form grits of about 2 mm size

↓

Sautéed in ghee (5g/100g sample) and sealed in polythene bags

Figure 1: Process flow chart for the corn grit preparation for the formulation of instant maize mix

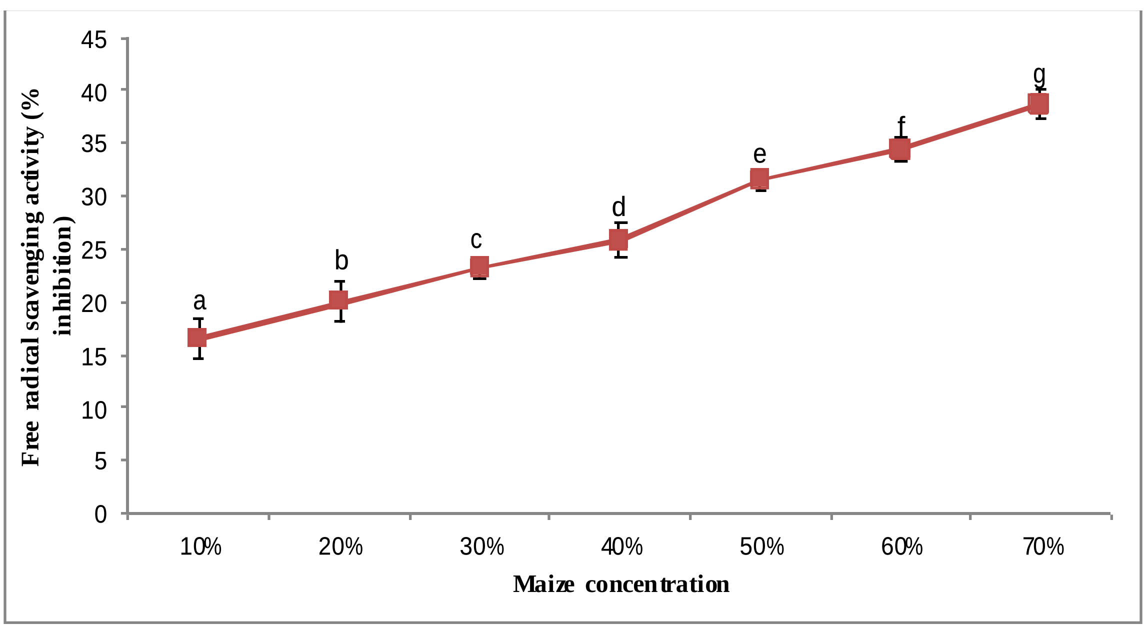

Figure 2: Free radical scavenging activity of maize incorporated instant maize mix

ISSN:0971-1260
Vol-22- Issue-12-November-2019

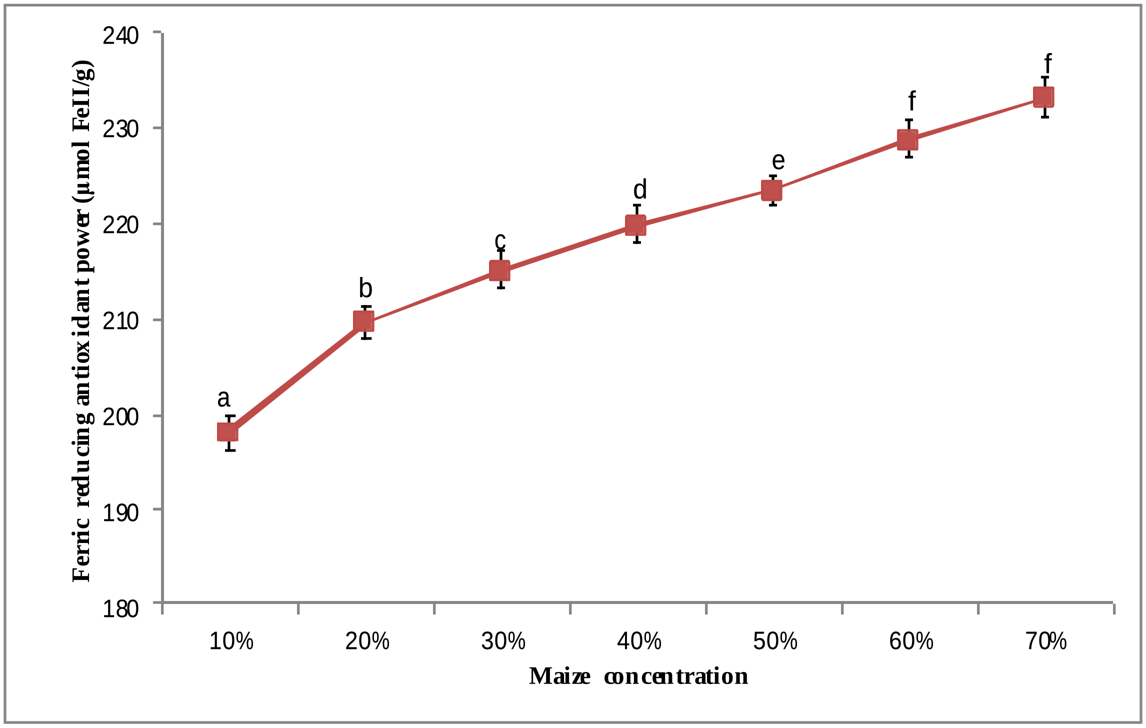

Figure 3: Ferric reducing antioxidant power of maize incorporated instant maize

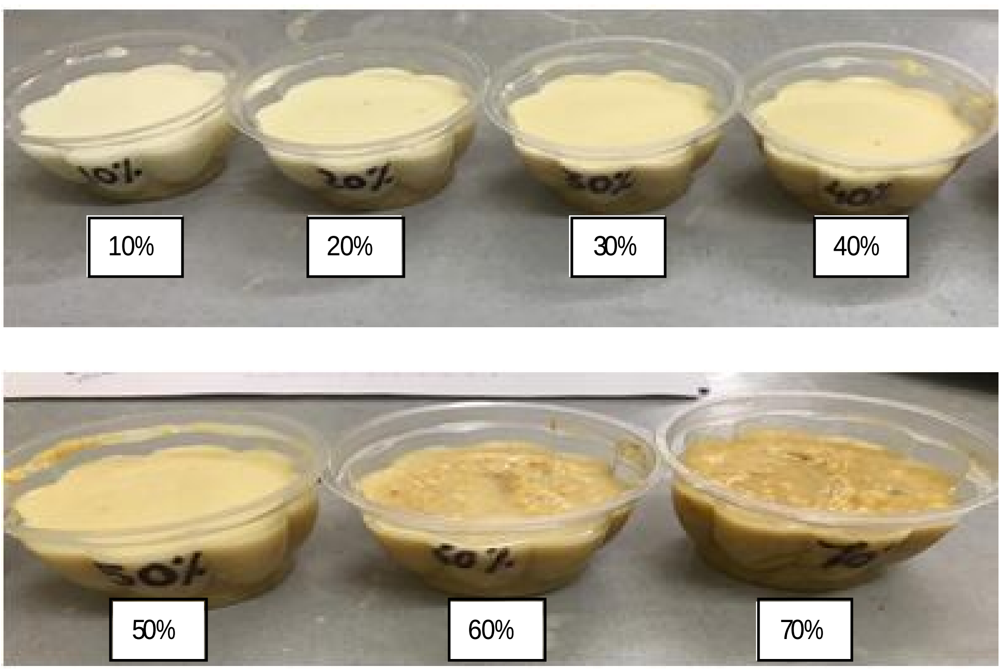

Figure 4: Pictorial presentation of different concentration of maize based cooked instant mix porridge

ISSN:0971-1260
Vol-22- Issue-12-November-2019

Table 1: Details of treatment combinations for the development of instant maize mix

Treatments	Corn Grits (%)	Milk Powder (%)	Sugar (%)
T1	10	70	20
T2	20	60	20
T3	30	50	20
T4	40	40	20
T5	50	30	20
T6	60	20	20
T7	70	10	20

Table 2: Physical properties of maize supplemented instant mix

Treatments	Bulk Density (g/cm^3)	Water Absorption Capacity (%)	Oil Absorption Capacity (%)
10%	1.21±0.08^{a}	36.06±0.89^{a}	93.06±0.89^{a}
20%	1.23±0.09^{a}	43.08±1.08^{b}	96.08±1.07^{b}
30%	1.24±0.07^{a}	63.98±0.91^{c}	96.13±1.00^{b}
40%	1.27±0.10^{a}	84.13±1.00^{d}	102.13±1.10^{c}
50%	1.31±0.06^{b}	104.00±0.88^{e}	106.16±0.96^{d}
60%	1.38±0.08^{b}	120.10±1.05^{f}	106.18±1.08^{d}
70%	1.45±0.07^{c}	132.01±0.98^{g}	111.05±0.95^{e}

Each value is expressed as mean±S.D (n=3); values followed by same letter in the different column are not significantly different at $p<0.05$.

Table 3: Antioxidant content of maize based instant porridge mix

Treatments	Ascorbic Acid Content (mg/100g)	Carotenoid (µg/100g)	Flavonoids (mg CE/100g dw)	Total Phenol Content (mg GAE/100g dw)
10%	208.26±0.87^{g}	800.18±1.29^{a}	83.36±0.91^{a}	48.31±0.68^{g}
20%	176.06±0.89^{f}	1600.24±0.97^{b}	97.56±0.89^{b}	43.64±0.90^{f}
30%	156.13±0.56^{d}	1999.98±0.94^{c}	103.99±0.96^{c}	38.39±0.80^{e}
40%	159.05±0.35^{e}	2500.03±1.05^{d}	104.48±0.83^{c}	35.22±0.71^{d}
50%	133.25±0.21^{c}	2900.10±1.17^{e}	112.77±0.82^{d}	32.69±1.00^{c}
60%	113.08±0.25^{b}	3700.07±1.10^{f}	114.70±0.67^{e}	31.11±0.70^{b}
70%	104.06±0.12^{a}	3850.10±1.05^{g}	127.61±0.74^{f}	26.97±0.98^{a}

ISSN:0971-1260
Vol-22- Issue-12-November-2019

Each value is expressed as mean±S.D (n=3); values followed by same letter in the different column are not significantly different at $p<0.05$.

Table 4: Sensory Evaluation of the maize based instant mix

Treatments	Mouthfeel	Consistency	Flavor	Colour	Overall Acceptability
10%	6.40±1.5[a]	6.05±1.01[a]	6.50±1.58[a]	5.50±0.53[a]	5.40±0.52
20%	6.75±1.30[a]	6.60±1.05[a]	6.75±1.34[a]	6.20±0.79[a]	6.15±0.67
30%	7.35±1.25[a]	7.30±1.23[a]	7.60±1.15[a]	7.10±0.87[a]	7.35±0.94
40%	7.50±1.10[a]	7.35±1.13[a]	7.65±1.18[a]	7.20±0.92[a]	7.50±0.81
50%	7.25±0.75[a]	7.30±0.80[a]	7.55±0.72[a]	7.30±0.50[a]	7.60±0.47
60%	7.80±0.92[a]	7.55±0.82[a]	7.95±0.97[a]	7.55±0.67[a]	7.65±0.71
70%	7.30±1.08[a]	6.80±1.03[a]	7.10±1.20[a]	7.00±0.82[a]	6.95±1.01

Each value is expressed as mean±S.D (n=10); values followed by same letter in the different column are not significantly different at $p<0.05$.

Table 5: Proximate analysis of the most acceptable treatment (60%)

Nutrients	Amount
Moisture Content (%)	5.06±0.89
Ash Content (%)	1.53±0.90
Protein (%)	15.09±0.89
Fat (%)	1.49±0.71
Fiber (%)	3.09±0.84