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RESEARCH PAPER

Effect of Niger Seed Supplementation on Sensorial and Nutritional Attributes of some Common Indian Recipes

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Abstract

The sensorial and nutritional evaluation of four products developed by using niger seeds (*Guizotia abyssinica*) was investigated. *Idli, poha, dhokla* and pop ups were prepared by supplementing niger seeds at different levels for different recipes and were sensorily evaluated using 9 point hedonic rating scale. Incorporation of the quantity of niger seeds higher than 20% decreased the acceptability due to dark colour and high fibre content. *Idli, poha, dhokla* and pop ups, were found to be acceptable at 15, 20, 10 and 9% level of supplementation of niger seeds, respectively with overall acceptability scores as 8.3, 7.8, 8.5 and 7.8. The developed products were found to have increased nutritive value as compared to their respective control samples in terms of protein, fat, fibre, iron and *in vitro* protein digestibility. Supplementation of these products to the vulnerable groups can help in combating protein-energy malnutrition and anaemia.

Keywords: Niger seeds, malnutrition, food product development, pop-ups, nutritional evaluation, iron rich recipes

Nutritional status of an individual can be classified as normal or malnourished. Malnutrition refers to a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients. Nearly half of the children in India suffer from malnutrition. According to National Family Health Survey (NFHS-3) 2005-2006, 45.5% of the children are stunted, 47% are underweight and 15.5% are wasted. Apart from the Protein-Energy Malnutrition (PEM, which includes marasmus and kwashiorkor), there exists another form, which is less visible as a result of vitamins and minerals deficiencies, known as Micronutrient deficiency (MND).

At present, the international edible oilseed market is dominated by a few crop species such as soybean (*Glycine max*), oilseed rape (*Brassica napus*) and sunflower (*Helianthus annuus*). To meet the demand, there is a need not only to increase the production of the major oil crops but also to diversify the sources by improving and increasing the production of minor oil crops, such as niger (*Guizotia abyssinica*).

Niger seed is of Ethiopian origin and grows in many tropical and temperate zones, where Ethiopia and India are the chief niger seed producing countries of the world. In India, niger is being grown in the States of Madhya Pradesh, Orissa, Maharashtra, Bihar, Karnataka and Andhra Pradesh. Common names in English include Niger, nyger, or nyjer.

Niger seed is a concentrated source of energy, protein, iron and also a rich source of linoleic - an essential fatty acid. It contains 483 calories, oil (30% - 40%), protein (10-25%), soluble sugars (12-18%), crude fibre (10-20%), moisture (10-11%) and ash (4%) (Rao, 1994). Proteins recovered from soya and groundnut

cakes from the oil refineries have been extensively used as protein sources for enhancing the nutritional quality of foods. Nigerseed meal and defatted flour was reported to have a good amino acid score and protein efficiency ratio (Bhagya and Sastry, 2003). Furthermore, it is a good source of vitamin E because almost all of the tocopherols are α-tocopherol (Ramadan and Moersel, 2002; Marini *et al.*, 2003).

Niger seed is reported to have a very high amount of iron (56.7mg/100g) among the plant based foods and may be of immense help in improving the iron status of vulnerable population group (Gopalan *et al.,* 2007). Barnwal and Bhatnagar, (2013) found that the germination and soaking the seeds increased the bioavailablity of iron i.e. 37.17 and 5.24%, respectively in the niger seeds than whole seeds due to the reduction of phytic acid content.

Niger seed is used in human food mainly as a condiment/spice in the frying of vegetables. These are also used in animal feed because of their high protein content. Their seeds contain energy for the sprouting embryo mainly as oil, compared with cereals, which contain the energy in the form of starch (McKevith, 2005). The utilization of niger seed proteins in human food is be very limited due to the presence of a high fiber content and a dark colour of the cake. Considering all these facts in view, a need is felt to exploit the underutilized crops so as to improve the nutritional status of the vulnerable groups by diet diversification. Accordingly, the present study was carried out with the objectives of formulating common Indian products supplemented with niger seeds and evaluate the same from sensory and nutritional point of view.

MATERIALS AND METHODS

Preparation of Niger Seed Products

All the raw ingredients (semolina, bengal gram flour, chickpea flour, rice flour, rice flakes, vegetables, oil, curd and spices and niger seeds) were procured in one lot from the local market of Ludhiana city (Punjab, India). The niger seeds were thoroughly cleaned for impurities before using in the preparations. Various products namely *Idli, Poha*, *Dhokla,* and Pop Ups were prepared in the Food Laboratory of Department of Food and Nutrition, College of Home Science, PAU,

Table 1: Ingredients used in the developed products

Code	*Idli*	*Code*	*Poha*	*Code*	*Dhokla*	*Code*	*Pop Ups*
I_C	Semolina (100%) + curd	P_C	Rice flakes (100%) + vegetables	D_C	Bengal gram flour (100%) + curd	PU_C	Rice flour (85%) + chickpea flour (15%)
I_1	Semolina (90%) + curd + raw niger seeds (10%)	P_1	Rice flakes (90%) + vegetables + sprouted niger seeds (10%)	D_1	Bengal gram flour (90%) + curd + raw niger seeds (10%)	PU_1	Rice flour (83.5%) + chickpea flour (13.5%) + powdered niger seeds (3%)
I_2	Semolina (85%) + curd + raw niger seeds (15%)	P_2	Rice flakes (85%) + vegetables + sprouted niger seeds (15%)	D_2	Bengal gram flour (85%) + curd + raw niger seeds (15%)	PU_2	Rice flour (82%) + chickpea flour (12%) + powdered niger seeds (6%)
I_3	Semolina (80%) + curd + raw niger seeds (20%)	P_3	Rice flakes (80%) + vegetables + sprouted niger seeds (20%)	D_3	Bengal gram flour (80%) + curd + raw niger seeds (20%)	PU_3	Rice flour (80.5%) + chickpea flour (10.5%) + powdered niger seeds (9%)
						PU_4	Rice flour (79%) + chickpea flour (9%) + powdered niger seeds (12%)

Ludhiana. These products were prepared using standardized recipe with supplementation of niger seeds at different levels ranging from 3-20% (Table 1).

Sensory analysis of the developed products

The developed products were sensorily evaluated using nine-point hedonic rating scale by a semi-trained panel of 12 judges (all non-smoker females) from Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ludhiana. The judges were served one control (0% supplementation) and three test samples formulated by using different levels of niger seeds in random order to prevent any biasedness. The evaluation was carried out in a well lit food laboratory of the department at the mid morning time. Depending upon the acceptability of the products, scores were given by the panel on nine-point hedonic rating scale which ranged from 1 (disliked extremely) to 9 (liked extremely) (Rangana, 1986). The most acceptable products were subjected to further chemical analysis.

Chemical analysis

The control samples as well as the most acceptable ones were thoroughly mixed in a blender and dried in an oven at (60±20°C) in petri dishes. The dried samples were ground to fine powder and stored in airtight polythene bags for further chemical analysis. Estimation of Proximate composition- moisture, protein, fat, fibre, ash, carbohydrate and energy was measured by using AOAC (2000) standard methods. Iron estimation was carried out by using AOAC (1980) standard method. The estimation of *In vitro* protein digestibility was determined by using method of Akeson and Stachman (1964).

Statistical Analysis

All determinations were carried out in triplicate and results were expressed as mean ± standard error. The data were analysed with the help of various statistical tools. To test the significant difference between the control and the experimental samples, independent t-test and analysis of variance one way were applied to compare the nutrient content of the control (0% supplementation) and the supplemented samples using SPSS 16 software. The significant difference was checked at 5% and 1% level of significance. All the assumptions of the model were verified.

RESULTS AND DISCUSSION

The results of study of various products *viz., Idli, poha, dhokla* and pop ups by supplementing niger seeds at different levels are presented here.

Organoleptic evaluation of developed products

The sensory evaluation scores for the products are given in Table 2. *Idli* was found to be highly acceptable at 15% supplementation level with acceptability score of 8.3 while the control sample was liked extremely with the overall acceptability score of 8.7. However, there was no significant difference between the most acceptable sample and the control sample in terms of appearance, colour, texture, flavor and taste at 5% level of significance. Pooja (2012) found that *idli* prepared with 5% fenugreek seeds flour was acceptable with mean overall acceptability score of 6.27 on 9 point hedonic rating scale.

Poha was found to be acceptable at 20% supplementation level with overall acceptability score of 7.8 on 9 point hedonic rating scale with significant difference ($p<0.05$) from the control sample with overall acceptability score of 8.6. Sprouted niger seeds were used in the preparation of the *poha.* In *poha,* niger seeds were supplemented in the form of sprouts, so as to make them soft because of the short cooking time in *poha*. Supplementation of more than 20% niger seeds was however not acceptable in terms of appearance due to its black colour and high fiber content.

With respect to *Dhokla,* it was found to be highly acceptable at 10% level of supplementation with non-significant difference ($p<0.05$) from the control sample with the overall acceptability score of 8.5. However, there was no significant difference between the control and accepted sample in terms of appearance, colour, texture, flavor and taste. Bansal, (2013) developed *dhokla* by substituting semolina

Table 2: Organoleptic scores for the developed products

Levels	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
			Idli			
I_C	$8.8^{a}\pm0.11$	$8.8^{a}\pm0.13$	$8.7^{a}\pm0.14$	$8.7^{a}\pm0.14$	$8.8^{a}\pm0.13$	$8.7^{a}\pm0.12$
I_1	$8.6^{ab}\pm0.15$	$8.7^{a}\pm0.14$	$8.7^{a}\pm0.14$	$8.8^{a}\pm0.13$	$8.5^{ab}\pm0.15$	$8.6^{a}\pm0.13$
I_2^*	$8.3^{ab}\pm0.22$	$8.3^{a}\pm0.19$	$8.3^{a}\pm0.19$	$8.4^{ab}\pm0.19$	$8.2^{ab}\pm0.17$	$8.3^{ab}\pm0.17$
I_3	$7.9^{b}\pm0.26$	$8.1^{a}\pm0.26$	$8.1^{a}\pm0.26$	$7.8^{b}\pm0.27$	$7.9^{b}\pm0.23$	$8.0^{b}\pm0.24$
			Poha			
P_C	$8.7^{a}\pm0.14$	$8.6^{a}\pm0.15$	$8.5^{a}\pm0.15$	$8.7^{a}\pm0.14$	$8.4^{a}\pm0.15$	$8.6^{a}\pm0.13$
P_1	$8.3^{ab}\pm0.19$	$8.4^{a}\pm0.19$	$8.3^{a}\pm0.22$	$8.3^{ab}\pm0.22$	$8.2^{a}\pm0.21$	$8.3^{ab}\pm0.18$
P_2	$8.0^{ab}\pm0.21$	$8.2^{a}\pm0.21$	$8.1^{a}\pm0.23$	$8.3^{ab}\pm0.22$	$8.3^{a}\pm0.22$	$8.2^{ab}\pm0.19$
P_3^*	$7.7^{b}\pm0.28$	$7.9^{a}\pm0.29$	$7.8^{a}\pm0.28$	$7.8^{b}\pm0.28$	$7.9^{a}\pm0.23$	$7.8^{b}\pm0.25$
			Dhokla			
D_C	$8.7^{a}\pm0.19$	$8.6^{a}\pm0.19$	$8.7^{a}\pm0.19$	$8.5^{a}\pm0.19$	$8.5^{a}\pm0.15$	$8.6^{a}\pm0.16$
D_1^*	$8.5^{a}\pm0.19$	$8.5^{a}\pm0.15$	$8.7^{a}\pm0.14$	$8.4^{a}\pm0.15$	$8.4^{a}\pm0.15$	$8.5^{ab}\pm0.12$
D_2	$8.1^{a}\pm0.19$	$8.1^{a}\pm0.19$	$7.9^{ab}\pm0.26$	$8.0^{a}\pm0.21$	$7.8^{a}\pm0.21$	$8.0^{ab}\pm0.19$
D_3	$8.1^{a}\pm0.19$	$7.9^{a}\pm0.23$	$7.7^{b}\pm0.26$	$7.8^{a}\pm0.21$	$7.8^{a}\pm0.21$	$7.9^{b}\pm0.19$
			Pop Up			
PU_C	$8.8^{a}\pm0.11$	$8.8^{a}\pm0.11$	$8.7^{a}\pm0.14$	$8.8^{a}\pm0.13$	$8.8^{a}\pm0.13$	$8.8^{a}\pm0.10$
PU_1	$8.6^{a}\pm0.15$	$8.7^{a}\pm0.14$	$8.5^{ab}\pm0.15$	$8.6^{ab}\pm0.15$	$8.6^{ab}\pm0.15$	$8.6^{a}\pm0.13$
PU_2	$8.3^{a}\pm0.14$	$8.4^{a}\pm0.15$	$8.3^{abc}\pm0.18$	$8.4^{ab}\pm0.19$	$8.4^{ab}\pm0.19$	$8.4^{ab}\pm0.14$
PU_3^*	$7.7^{b}\pm0.14$	$7.7^{b}\pm0.19$	$7.8^{bc}\pm0.25$	$7.8^{bc}\pm0.24$	$7.8^{bc}\pm0.24$	$7.8^{bc}\pm0.18$
PU_4	$7.4^{b}\pm0.19$	$7.6^{b}\pm0.23$	$7.9^{c}\pm0.23$	$7.9^{c}\pm0.23$	$7.9^{c}\pm0.23$	$7.6^{c}\pm0.20$

Means with different notation (a,b and c) indicate significant difference at 5% level of significance.

I_C- Control (0% supplementation), I_1- 10% Raw Niger Seeds, I_2- 15% Raw Niger Seeds, I_3- 20% Raw Niger Seeds.

P_C- Control (0% supplementation), P_1- 10% Sprouted Niger Seeds, P_2- 15% Sprouted Niger Seeds, P_3- 20% Sprouted Niger Seeds.

D_C- Control (0% supplementation), D_1- 10% Raw Niger Seeds, D_2- 15% Raw Niger Seeds, D_3- 20% Raw Niger Seeds.

PU_C- Control (0% supplementation), PU_1- 3% Raw Niger Seeds, PU_2- 6% Raw Niger Seeds, PU_3- 9% Raw Niger Seeds, PU_4- 12% Raw Niger Seeds.

*Most acceptable level of supplementation

and Bengal gram flour with partially defatted peanut flour at different levels. 15% substitution was organoleptically accepted with 8.04 scores on nine-point hedonic rating scale.

The Pop ups were found to be acceptable at 9% supplementation level with overall acceptability scores of 7.8 whereas the control sample was liked extremely with overall acceptability score of 8.8 on nine point hedonic rating scale (Table 2). Increasing the supplementation level of niger seeds resulted in decrease in the mean scores of all the sensory parameters. Jain *et al.* (2012) developed extruded snacks by incorporating 3% niger seeds along with other ingredients and found the extrudates were acceptable with the mean organoleptic scores ranging from 7.8 to 8.7 at 9 point hedonic rating scale. Sisodia, (2015) found that the corn extrudates supplemented with 5% niger seeds were acceptable with mean overall acceptability of 7.7 on nine-point hedonic rating scale.

Proximate composition of developed products

The proximate compositions of control and test samples of value added products using niger seeds have been presented in Table 3.

Idli

It was observed that the moisture content of *Idli* prepared with 15% niger seeds was 5.3% as compared to 5.0% of the control sample. Significantly higher protein ($p<0.01$) content was observed in *Idli* with 15% niger seeds as compared to the control as 13.4 and 11.5%, respectively. Pooja and Ritu, (2012) found that the protein content of *idli* prepared from 5% raw fenugreek seeds flour was 15.6%. The fat content also increased in I_2 treatment than control i.e. from 7.3 to 10.6%. The fibre content in control was found to be 1.0% and higher in I_2 treatment i.e. 5.4%. There was however, a non-significant difference in the ash content of control and accepted sample i.e. 3.8 and 3.9%, respectively. The carbohydrate content of I_2 was found to be 61.4g per 100g and the energy content was 364.8Kcal. Bansal, (2013) found moisture (3.70g), protein (19.50g), fat (5.15g), fibre (2.25g), ash (1.50g), carbohydrate (67.40g) and energy as 393.9Kcal per 100g in *idlis* made from 20% partially defatted peanut flour.

Poha

The moisture content of *poha* ranged from 5.3% for the control to 4.4% for P_3 treatment i.e. *poha*

Table 3: Proximate composition of the developed products (g/100g on dry weight basis)

Treatment	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Carbo-hydrate (%)	Energy (Kcal)
			Idli				
Control (0% supplementation)	5.0±0.02	11.5±0.12	7.3±0.02	1.0±0.03	3.8±0.07	71.4	397.6
Accepted (I_2-15% niger seeds)	5.3±0.02	13.4±0.15	10.6±0.32	5.4±0.06	3.9±0.04	61.4	394.8
t-value	12.74**	11.57**	12.46**	75.64**	NS		
			Poha				
Control (0% supplementation)	5.3±0.10	10.1±0.16	4.4±0.15	1.5±0.03	1.9±0.11	76.9	387.3
Accepted (P_3- 20% niger seeds)	4.4±0.04	12.7±0.06	10.7±0.03	6.5±0.03	2.8±0.04	62.9	398.6
t-value	10.98**	18.77**	47.97**	140.69**	9.81**		
			Dhokla				
Control (0% supplementation)	4.7±0.01	22.9±0.12	9.8±0.05	0.2±0.01	1.5±0.14	60.9	423.3
Accepted (D_1- 10% supplementation)	5.6±0.02	24.1±0.16	15.4±0.05	3.6±0.13	2.6±0.03	48.7	429.9
t-value	51.56**	7.59**	94.80**	30.54**	8.79**		
			Pop Ups				
Control (0% supplementation)	7.0±0.03	7.7±0.10	0.2±0.01	0.5±0.06	1.0±0.01	83.6	367.3
Accepted (PU_3- 9% supplementation)	6.4±0.02	8.5±0.06	0.4±0.01	1.2±0.13	1.1±0.04	82.4	366.6
t-value	17.32**	7.75**	13.03**	6.60**	4.94**		

Values are expressed as Mean±SE.; *Significant at 5% level of significance; ** Significant at 1% level of significance

supplemented with 20% sprouted niger seeds. The protein, fat, fibre and ash content of the *poha* with acceptable levels of niger seeds were found to be 12.7, 10.7, 6.5 and 2.8 g/100 g, respectively, the values being significantly higher ($p<0.01$) as compared to its control counterparts. The calculated values for carbohydrate content of the control and P_3 treatment were found to be 76.9 and 62.9g per 100g, respectively. The energy content of the accepted product was found to be 398.6 Kcal. Sharma (2009) supplemented vegetable *poha* with 30% oats and reported moisture 5.0g, protein 9.8g, crude fat 6.8g, fibre 3.9g, carbohydrate 73g and energy as 393Kcal per 100g.

Dhokla

As discussed earlier, the *dhokla* supplemented with 10% niger seeds was fond to be the most acceptable, which had a significantly higher ($p<0.01$) protein, fat, fibre and ash content as compared to the control (with 0% supplementation). However, carbohydrate content of the control sample was found to be higher than the sample supplemented with the niger seeds, the values being 60.9 and 48.7%, respectively. The energy content of the supplemented product was higher than its control counterpart i.e. 423.3 and 429.9 Kcal, respectively. The reason for this increase might be due to the inclusion of niger seeds which are rich source of energy. Bansal (2013) supplemented *dhokla* with 15% partially defatted peanut flour and reported protein 28.90g, fat 9.45g and fibre 2.35g per 100 g.

Pop Ups

Pop-ups supplemented with 9% level of niger seeds had a lower moisture content (6.4%) as compared to the control sample (7.0%). As per the previously discussed food products, similar trend of having higher protein, fat, fibre and ash content was observed in pop-ups supplemented with niger seeds as compared to their control counterpart. The values being 8.5, 0.4, 1.2 and 1.1%, respectively for the supplemented pop-ups. The carbohydrate and energy content in the control was high i.e. 83.6% and 367.3Kcal, whereas it was 82.4% and 366.6Kcal in the supplemented pop ups. Sisodia (2015) reported that pop ups made from corn flour with 5% niger seeds had moisture 7.23g, protein 15.4g, fat 1.7g, fibre 2.8g, total ash 3.81g, carbohydrate 70.6g and energy content as 353Kcal per 100g.

The increased protein, fat, fibre and ash content in the niger seeds supplemented products might be due to the higher content of the above said nutrients in the seeds.

Iron content

Niger seed are an excellent source of iron (56.7 mg/100g) as reported by Gopalan *et al*., (2007), so all the products supplemented with niger seeds showed significantly higher ($p<0.05$) iron content as compared to their control counterpart (Fig. 1).

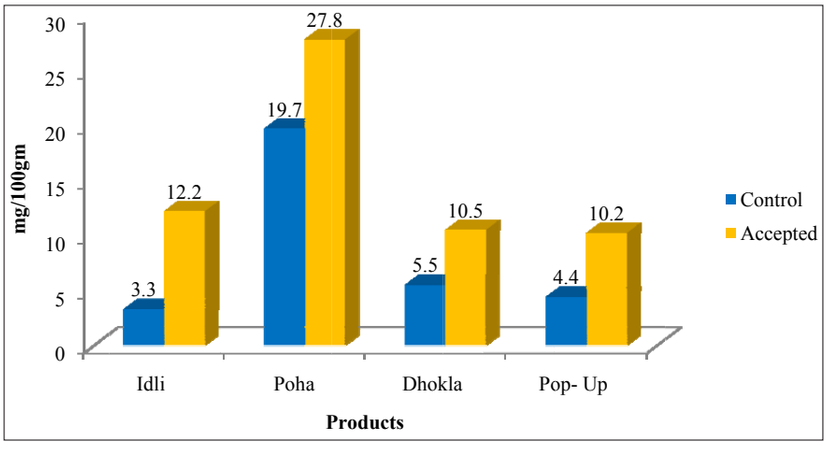

Fig. 1: Iron content of the control and developed products

Idli supplemented with 15% niger seeds showed higher iron content i.e. 12.2 mg/100g as compared to its control sample (3.3mg/100g). The accepted sample of *poha* had the highest iron content i.e. 27.8mg/100g amongst. At 10% level of supplementation, the iron content in *dhokla* also increased to 10.5 from 5.5 mg/100g. With 9% supplementation of niger seeds in the pop ups, the iron content of the accepted sample increased to 10.2 mg/100g as compared to its control counterpart having 4.4 mg/100g iron.

Sisodia, (2015) reported the iron content of corn based extrudates as 19.3mg/100g with 5% niger seeds supplementation.

In vitro protein digestibility of developed products

The *in vitro* protein digestibility of the developed products has been presented in the Fig. 2. The *in vitro* protein digestibility of the developed products was found to be significantly higher ($p<0.05$) than their control counterparts due to the incorporation of niger seeds. The *in vitro* protein digestibility of the developed products ranged from 42% in *idli* supplemented with 15% niger seeds to 83.2% in the *dhokla* with 10% niger seeds. The values for *idli, poha, dhokla* and pop ups (at 15, 20, 10 and 9% supplementation level) increased from 31.3, 51.9, 76.3 and 63.0% to 42.0, 63.1, 83.2 and 69.8%, respectively, indicating a significantly higher increase of 34.2, 21.6, 9.04 and 10.8%, respectively. Sisodia (2015) also reported that the corn extrudates prepared from 5% niger seeds showed 83.4% digestibility of protein, which was higher than that found in the present study.

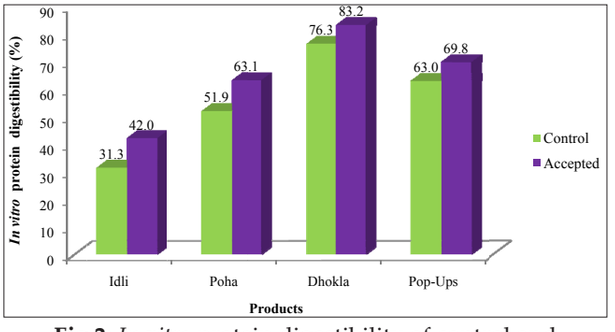

Fig 2: *In vitro* protein digestibility of control and developed products

CONCLUSION

All the developed value added products using niger seeds were found to be acceptable at 9-20% levels. Pop Ups, *dhokla* and *idli* were found to be acceptable at 9, 10 and 15% level of supplementation of niger seeds, respectively. *Poha* was found to be acceptable at 20% level of supplementation. Incorporation of the niger seeds higher than 20% causes the colour of the product to become darker and due to high fibre content, the acceptability tends to decrease. The developed products were found to have higher protein, fat, fibre, energy, iron and *in vitro* protein digestibility as compared to their control samples. Keeping in view the economic and nutritional benefits of niger seeds, these value added products can be supplemented to eradicate malnutrition and anaemia besides becoming a part of the supplementary feeding programmes.

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