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Development, Chemical Composition and Antioxidant Activity of *Dosa* Prepared Using *Bengal* Gram Seed Coat

Beniwal Priyanka and Jood Sudesh

Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence should be addressed to Beniwal Priyanka, priya.bnwl@gmail.com; sudeshjood@gmail.com

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Abstract A popular fermented product, *dosa* was prepared by incorporating *bengal* gram seed coat, a by-product of legume milling industry at 5, 10 and 15% levels. On the basis of sensory evaluation, the 5% *bengal* gram seed coat substituted *dosa* was analyzed for its chemical composition and antioxidant activity against control *dosa*. Incorporation of seed coat in *dosa* resulted in a significant increase in crude and total fibre content of *dosa*. Crude fat, ash, total soluble sugar except non-reducing sugar content decreased significantly in seed coat supplemented *dosa* compared to control *dosa*. Antioxidant activity was also increased in *bengal* gram seed coat incorporated *dosa*.

Keywords *Dosa; Bengal Gram Seed Coat; Sensory Evaluation; Chemical Composition; Antioxidant Activity*

1. Introduction

Dosa is a thin, crispy textured and desirably sour flavour fermented product (Sekar and Mariappan, 2007). The fermentation process causes enrichment and improvement of food through flavour, aroma and change in texture, preservation by producing organic acids, nutritional enrichment, reduction of endogenous toxins and reduction in the duration of cooking and thereby fuel requirement. Normally, *dosa* is prepared from wet ground batter of rice and black gram (Sulochana and Bakiyalakshmi, 2011). In India, *dhal* (dehulled split pulse) milling is the third largest food grain processing industry after rice and wheat milling. The average yield of *dhal* in the commercial mills is about 75 % and the rest material (about 25 %) is obtained in the form of various types of by-products (Kurien and Parpia, 1968). These by-products comprises of seed coat/husk, powder, large and small brokens, shriveled and under-processed grains. Presently, these are disposed of only as feed grade material, fetching low remunerative prices (Ramakrishnaiah, et al., 2004). Most of these by-products are rich in protein, calcium, iron, zinc and fibre, so these can be utilized for making health foods for different age groups (Yadav, et al., 2007). So far, fewer attempts have been made to utilize these by-products in value-addition of food products for human consumption.

In the present study attempts has been made to develop fibre rich *dosa* by incorporating *bengal* gram seed coat. The incorporated *dosa* was then analyzed for its sensory evaluation, chemical composition and antioxidant activity.

2. Materials and Methods

2.1. Procurement and Processing of Materials

Bengal gram seed coat, were collected in a single lot from legume milling industries. They were washed in water to remove dirt, dipped in boiled water for 10 min, dried and ground to fine powder for further use. Other ingredients for preparation of dosa were procured from local market.

2.2. Preparation and Sensory Evaluation of *dosa*

Using different combination of raw material different types of *dosa* were developed (Table 1) and its preparation method is presented in Figure 1. For sensory evaluation control and by-products incorporated *dosa* samples were evaluated by ten semi-trained panelists. Sensory attributes like colour, appearance, flavour, texture, taste and overall acceptability for all samples were assessed using a nine-point Hedonic Scale (1=dislike extremely, 5=neither like nor dislike, 9=like extremely). On the basis of sensory evaluation, *dosa* exhibited higher scores for sensory characteristics were selected for further analysis.

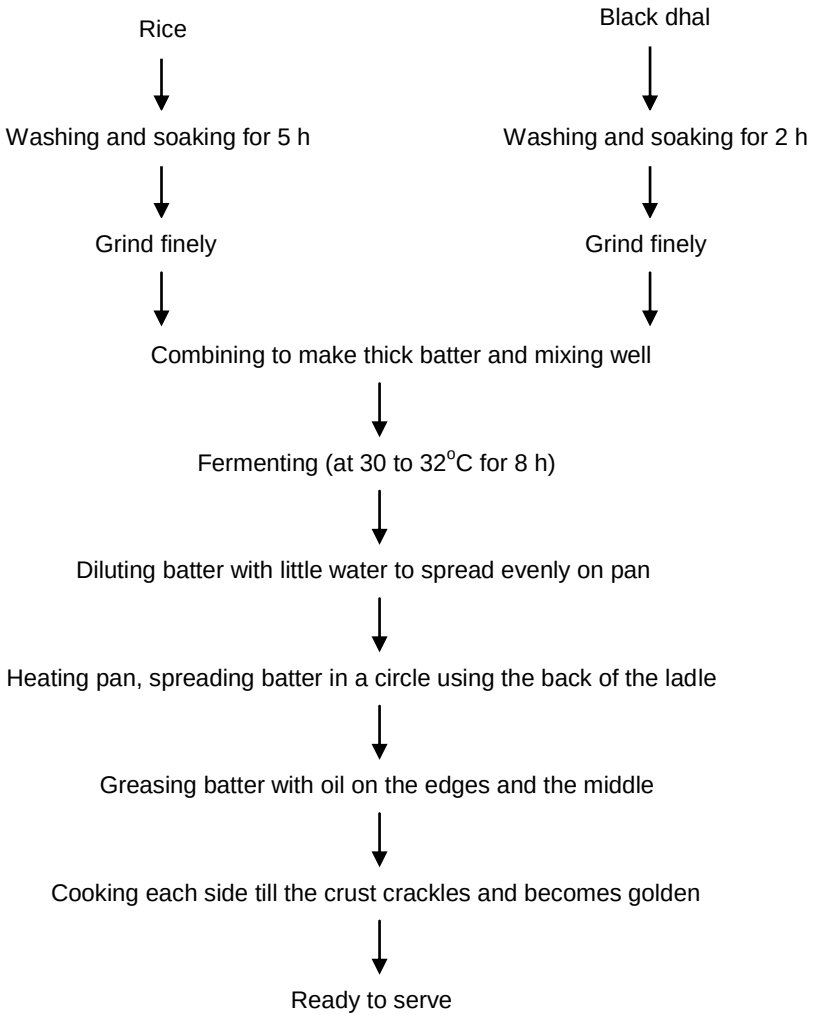

Figure 1: *Flow Diagram for dosa Preparation*

Table 1: *Recipe Formulation for dosa*

Ingredients	***Dosa* C** (g)	***Dosa* 10** (g)	***Dosa* 20** (g)	***Dosa* 30** (g)
Rice	85	80	75	70
Black gram dhal	15	15	15	15
Bengal gram brokens	-	5	10	15

2.3. Chemical Analysis

For chemical analysis, control and most acceptable *bengal* gram seed coat supplemented *dosa*, were dried at 50-60^{o}C for 8 h. The dried samples were milled to fine powder. Moisture, crude protein, crude fat, crude fibre and ash were analyzed using standard methods of Association of Official Analytical Chemists (AOAC, 2000). Total carbohydrates were calculated by difference. Total soluble sugars were extracted by refluxing in 80 per cent ethanol (Cerning and Guilhot, 1973). Starch from sugar free pallet was extracted in 52 per cent perchloric acid at room temperature (Clegg, 1956). Quantification determinations of total soluble sugar and starch were carried out accordingly to colorimetric method (Yemm and Willis, 1954). Reducing sugars were estimated by Somogyi's modified method (Somogyi, 1945). Non-reducing sugars were determined by calculating the difference between total soluble sugars and reducing sugars. Total dietary fibre was analyzed enzymatically, according to the method of Furda (1981). For antioxidant activity, sample was extracted by the method of Xu, et al. (2007). Total phenolic contents were estimated by the method of Singleton and Rossi (1965) and DPPH radical scavenging activity was evaluated by the DPPH method of Hudec, et al. (2007).

2.4. Statistical Analysis

All assays were carried out in triplicates. Appropriate statistical analyses were carried out as per the methods described by Sheoran and Pannu (1999).

3. Results and Discussion

3.1. Sensory Evaluation

The sensory profile of *dosa* is presented in Table 2. Although mean sensory scores for overall acceptability was slightly lower for *dosa* with *bengal* gram seed coat as compared to control *dosa*. And, with the increase of substitution level of *bengal* gram seed coat from 5 to 15 per cent the mean scores for overall acceptability decreased. The 5 % *bengal* gram seed coat incorporated *dosa* was rated from 'liked moderately' for overall acceptability and was further studied for chemical composition. While, 10 and 15 % of bengal gram seed coat substituted dosa were rated as 'liked slightly' and 'neither liked not disliked', respectively.

Table 2: *Mean Scores of Sensory Evaluation of Dosa*

Products	Colour	Appearance	Aroma	Texture	Taste	Over All Acceptability
***Dosa* Control**	8.750.13	7.650.09	8.450.14	7.450.12	7.900.12	8.040.24
***Dosa* 5 % seed coat**	7.850.17	7.450.13	7.250.16	7.350.16	7.180.14	7.410.41
***Dosa* 10% seed coat**	6.450.15	6.250.17	6.150.11	6.850.15	6.650.16	6.470.37
***Dosa* 15% seed coat**	6.150.14	5.140.16	5.100.14	5.650.19	6.250.19	5.660.31
CD (P<0.05)	0.16	0.12	0.15	0.17	0.15	0.32

Values are mean ± SD of ten independent determinations

3.2. Proximate Analysis

The proximate composition of control and 5 per cent *bengal* gram seed coat supplemented *dosa* samples are given in Table 3. The values for crude protein (5.99 %) and crude fat (15.15 %) decreased significantly while the values for moisture (42.37 %), crude fibre (2.34 %) and ash (2.33 %) were found to be higher in *bengal* gram seed coat incorporated *dosa* sample as compared to control *dosa* sample. Crude fibre is mainly concentrated in the seed coat (Emami and Tabil, 2002), because of which replacement of rice with *bengal* gram seed coat increased the fibre and ash amount in supplemented *dosa.*

Table 3: *Proximate Composition of Dosa*

Parameters	*Dosa Control*	*Dosa 5 % Seed Coat*
Moisture*	40.61±0.36	42.37±0.20
Crude protein	7.76±0.68	5.99±0.57
Crude fat	15.99±0.15	15.15±0.24
Crude fibre	0.32±0.22	2.34±0.27
Ash	2.08±0.14	2.33±0.12
Total carbohydrates	73.85±1.19	74.19±1.97

Values are mean ± SD of three independent determinations
*Moisture content on fresh weight basis

3.3. Carbohydrates

Total soluble and reducing sugar content was decreased in *bengal* gram seed coat supplemented *dosa* sample (8.77 and 2.27 g/100g) than in control *dosa* sample (9.37 and 3.49 g/100g). On the other hand, non-reducing sugar was observed to be increased in supplemented *dosa* sample. Control and *bengal* gram seed coat incorporated *dosa* sample provided an amount of 53.72 and 51.05 g starch per 100g, respectively. As the endosperm portion of the legume which consists mainly of starch had been removed completely from seed coat the starch and sugar content of bengal gram seed coat supplemented product decreased as compared to control product. These results are in agreement with the earlier results reported by Sihag (2000) and Dhaka (2001) in legumes seed coat**.**

Incorporation of *bengal* gram seed coat in *dosa* increased total, soluble and insoluble dietary fibre content manifold as compared to control *dosa* sample. As fibre content is mainly located in outer layer of cereals or legumes and most of it is reduced during milling. Amount of dietary fibre is also affected by thicker hulls or seed coat of bengal gram (Jukantil, et al., 2012). The results of present study on dietary fibre content were found to be in concordance with the findings of earlier coworkers (Mamata, et al., 2012; and Sihag and Kwatra, et al., 2003).

Table 4: *Carbohydrate Content of Dosa*

Parameters	*Dosa Control*	*Dosa 5 % Seed Coat*
Total soluble sugar	9.37±0.25	8.77±0.57
Reducing sugar	3.49±0.57	2.27±0.65
Non-reducing sugar	5.88±0.96	6.50±0.80
Starch	53.72±1.34	51.05±1.08
Total dietary fibre	1.85±0.39	7.34±0.47
Soluble dietary fibre	1.23±1.12	3.42±1.14
Insoluble dietary fibre	0.62±0.33	3.92±0.24

Values are mean ± SD of three independent determinations

3.4. Antioxidant Activity

Antioxidants neutralize the plethora of free radicals generated continuously within the human body (Wang, et al., 2007). A number of synthetic antioxidants added nowadays to foodstuffs are being questioned for their probable toxic and carcinogenic effects, and replaced with natural alternatives (Dewato, et al., 2002). Keeping this in mind, antioxidant activity of control and *bengal* gram seed coat supplemented *dosa* samples were evaluated. The results presented in Table 5 showed that the extracts of *dosa* sample prepared from supplementation of *bengal* gram seed coat showed significantly different antioxidant activity as compared to control *dosa*. Maximum amount of total phenolic content (27.17 mg GAE/g) and DPPH radical scavenging activity (28.49%) were observed in 5 per cent *bengal* gram seed coat incorporated *dosa* and minimum in control *dosa* (24.42 mg GAE/g and 27.24 %, respectively). These values showed that *bengal* gram seed coat can be added effectively to food products to increase their antioxidant activity. This is because; during milling antioxidant activity of cereals/legumes decreased as these are mainly present in bran layer (Vaher, et al., 2010). So, addition of seed coat in dosa increased the antioxidant activity.

Table 5: *Antioxidant Activity of Dosa*

Parameters	*Dosa Control*	*Dosa 5 % Seed Coat*
Total phenolic content (mg GAE/g)	24.42±1.10	27.17±3.92
DPPH free radical scavenging activity (%)	27.24±1.06	28.49±1.20

Values are mean ± SD of three independent determinations

4. Conclusion

The shortage and sharp rise in prices of the conventional foodstuff have forced nutritionists to investigate alternative ones. By-products of food processing industries represent one such class of alternatives. Legume milling industries in India run at a very marginal profit and variation in market or crop failure immediately affects the financial status of the legume milling industries. So, any additional income to a legume miller will be of great help. From the present study it can be observed that, *dosa* prepared using *bengal* gram seed coat, a by-product after milling of *bengal* gram have higher nutritional value in terms of fibre and antioxidant activity as compared to the control *dosa*. They can be served as functional ingredients to combat degenerative disorders. Thus, it can be concluded that *bengal* gram seed coat can be utilized as unconventional sources of nutrients because they are often discarded as waste or used as animal feed, which will provide them an economical importance also.

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