

Physico- Sensory Quality of Foxtail Millet (*Setaria italica*) Bran Enriched Muffins

Barbhai Mrunal^{1*} D. and T.V. Hymavathi²

¹PhD. Scholar, ²Professor and University Head,

Department of Foods and Nutrition, PGRC, Professor Jayashankar Telangana
State Agricultural University, Rajendranagar, Hyderabad

*Corresponding Author E-mail: mmrunal93@gmail.com

Received: 15.10.2020 | Revised: 26.11.2020 | Accepted: 30.11.2020

ABSTRACT

Foxtail millet bran obtained during milling or dehulling of grains are usually thrown, underutilized or find utility as animal feed. Given the excellent nutritional profile, antioxidant potential and health benefits associated with foxtail millet bran it can be used in formulating value added snacks. Thus, present study aimed at designing and evaluating muffins developed from refined wheat flour with incorporation of foxtail millet bran at 0, 10, 15, 20, 25 and 30%. Sensory evaluation results disclose that there was no significant difference in scores of control and muffins up to 30% bran addition. All bran enriched muffins scored above 7 and were acceptable up to 30%. Physical properties revealed that insignificant increase in weight and decrease in height and baking rate loss was noted in bran enriched muffins. Overall, it can be concluded that foxtail bran can be used as potential ingredient in value addition of muffins.

Keywords: Bran, Minor millet, Physical properties, Sensory, Underutilized.

INTRODUCTION

Millets – small seeded, drought resistant, indigenous crops were forgotten due to after effect of green revolution (Gopalan, 2014 & Pandiyan et al., 2019). But with the understanding of agrarian, nutritional and health benefits provided by millets, they are again gaining lot of attention (Mishra et al., 2017 & Kumar et al., 2018). Millets are classified as major (sorghum and pearl) and minor (finger, foxtail, little, kodo, barnyard, proso, and browntop) millet. Foxtail millet is

one such important millet known to be originated in China and is now grown widely in India, China, Russia, USA, Bangladesh and some parts of Europe (Sharma & Niranjan 2018 & Sharma et al., 2018). Foxtail millet is a good source of protein, fiber, minerals and antioxidants. The grain size is tiny and major part of total grain weight is husk contributing to 13.5%, bran and germ covering 1.5 – 2% (Dharmaraj et al., 2016 & Sharma & Niranjan 2018).

Cite this article: Mrunal, B.D., & Hymavathi, T. V. (2020). Physico- sensory quality of foxtail millet (*Setaria italica*) bran enriched muffins, *Ind. J. Pure App. Biosci.* 8(6), 28-33. doi: <http://dx.doi.org/10.18782/2582-2845.8438>

Primary processing of millet like dehulling is essential to improve the cooking quality, acceptability and storage life but given its small size it is difficult, thus leads to major grain losses (Amadou et al., 2013 & Taylor 2016). Dehulling is mainly done to remove bran and it is usually discarded or used as animal feed (Amadou et al., 2011 & Guo et al., 2018). It is known fact that outer layer of cereal grain i.e. bran and bran rich fractions are rich source of nutrients, dietary fiber and antioxidant compounds contributing to various health benefits, thus it can be used as functional ingredient (Alan et al., 2012 & Patel, 2015).

Similarly, millet bran obtained from millet processing can be employed as functional ingredient in value addition of various empty calorie foods. Bran obtained during dehulling or milling of foxtail millet is good source of protein (12.49 – 12.93%), fat (9.39 – 9.63%), fiber (42.56 – 51.69%) and ash (7.50 – 7.78%) (Liang et al., 2010 & Amadou et al., 2011). Studies have reported that foxtail millet bran extracts are rich source of phytochemicals like polyphenols, flavonoids thus contributing to antioxidant capacity of bran (Amadou et al., 2011; Sridevi et al., 2011; Suma, & Urooj 2012 & Kumari et al., 2017). Antioxidant and dietary fiber complex in bran are associated with numerous health benefits like reducing the risk of obesity, hypoglycaemic effect, lowering cholesterol levels, and prevention of oxidative stress (Vitaglione et al., 2008 & Patel, 2015). It was also reported that 35 kDa protein extracted from foxtail millet bran have therapeutic benefits and can be exploited as effective therapeutic agents for patients suffering with colon cancer (Shan et al., 2014a & Shan et al., 2014b). Similarly, antioxidant activity of foxtail millet bran oil was found effective against preventing hepatic injuries caused by ethanol in mice (Pang et al., 2014). Another study indicated that bound polyphenols of inner shell (BPIS) from foxtail millet bran can be used as potential pro-oxidant agent against inflammation and colon cancer (Shi et al., 2015 & Shi et al., 2017).

Considering all these beneficial health effects foxtail millet bran can be used as nutraceutical and functional ingredient in food processing industry. But challenge of utilizing bran as functional ingredient without damaging the sensorial acceptability of products. In current scenario bakery products like muffins are preferred snacks in all age groups. But they lack nutrients as they are mainly composed of refined wheat flour, sugar and fat. Thus, in present study attempt was made to develop value added muffins by incorporation of foxtail millet bran.

MATERIALS AND METHODS

Raw material and bran collection: Whole foxtail millet and other required raw materials were purchased from local market at Hyderabad. Foxtail millet was destoned, cleaned and dehulled. Dehulling was done at Millet Processing and Incubation Centre of PJTSAU, Hyderabad using stone abrasive dehuller for 30 minutes and bran was separated from the grain by winnowing. The collected bran was ground using grinder into finer particles and stabilized (microwave heating at 900W for 2.5minutes) before using for product development.

Muffin preparation: Initially refined wheat flour was replaced with stabilized foxtail millet bran at 0, 10, 15, 20, 25 and 30%. Further this flour mix was used to prepare muffins FM0, FM10, FM15, FM20, FM25 and FM30 respectively. Recipe described by Yaseen et al. (2012) was followed with slight modification. Firstly, flour mix (50g), salt (0.5g) and baking powder (2g) were mixed and sifted. Further in a bowl oil (20ml) and sugar (40g) were blended. To this milk (30ml), vanilla essence and egg (38g) were added and whipped and the flour mix was added and creamed properly till it became light and fluffy. Muffin batter was then poured in greased paper muffin cups into the mould. Muffins were baked in preheated oven at 180°C for 25 minutes. After cooling the muffins were subjected to sensory evaluation.

Sensory evaluation: The muffins were tested by panel of 21 semi-trained members at

sensory evaluation chamber, Professor Jayashankar Telangana State Agricultural University, Hyderabad. Muffin samples were coded and randomly presented to the panel members. The panelists were asked to use 9-point hedonic scale for scoring (Peryam & Pilgrim, 1957). All the members were given water and asked to rinse mouth in between testing the muffins to reduce the residual effect of taste from previous sample.

Physical properties: The muffins were subjected to measuring physical properties like height, weight and baking loss rate. All the measurements were average of 5 replications. Height was measured using calipers weight was measured with electronic weighing balance. Baking loss rate (%) was calculated as described by Heo et al. (2019).

Statistical analysis: Data is represented as mean \pm Standard deviation (SD). One-way ANOVA was conducted and means were compared to check the significance. Statistical analysis was done using INDOSTAT software for windows and Microsoft excel.

RESULTS AND DISCUSSION

Sensory Evaluation: The results for sensory evaluation are presented in Table 1 and Figure 1 depicts all muffins. It was observed from overall sensory results that there was no significant difference ($p>0.05$) among all the 5 treatments (FM10 – FM30) and control (FM0) muffins for all the attributes. The results for appearance indicate that FM0 (control muffin) with no bran and FM30 scored highest, whereas FM15 scored lowest. Similarly, for colour, control scored highest followed by FM10 and FM30. Though the colour slightly became darker with bran incorporation it was not much affected and was at par with control. Previous studies also report darkening of colour on addition of bran that led to slight decrease in preferences of panel members (Romjaun & Prakash 2013). No significant difference was noted in texture, taste or flavor. Texture showed slight variations in scores, many of the panel members did not enjoy the granular texture imparted by the bran, but some liked the texture due to addition of bran.

The preference for taste was slightly higher in FM30 though not significant, and this can be associated to the flavours imparted by various aromatic compounds present in the millet bran. Previous work has identified different aromatic compounds like aldehydes, alcohols and ketones, present in bran that can contribute to the grassy, husky and nutty flavour (Liu et al., 2012). Overall acceptability also revealed that bran enriched muffins scored slightly higher than control and were preferred by the semi-trained panel members but no significant difference was noted in scores. In totality, the sensory evaluation results revealed that all muffins prepared using bran enriched flour scored above 7 and had better acceptability like control muffins. On contrary, previous evidences suggest that wheat bran enriched muffins up to 24% were acceptable and less acceptable than control (Romjaun & Prakash 2013), and muffins enriched with barnyard bran were acceptable only up to 15% incorporation (Nazni & Karuna 2016).

Physical properties: The results for height, weight and baking rate loss are presented in Table 2 and it was observed that there was no significant difference among the treatments. The weight after baking slightly increased in bran enriched muffins compared to control. When weights before and after baking were compared, it was observed that in all muffins the weight decreased after baking. Though insignificant ($p>0.05$), weight after baking was lowest in control and it increased with addition of bran. The height of muffins after baking decreased with the bran incorporation. Baking rate loss (%) also decreased with increased bran addition. Though the decrease was insignificant ($p>0.05$), higher baking loss rate (%) was noted in control (FM0) and least in FM30. This increase in weight and decrease in height and baking rate loss can be associated to adverse effect of bran on gluten networks and making the product denser. The results are in accordance to that of dietary fiber enriched muffins developed by Heo et al. (2019) where decrease in height, baking rate loss and increase in weight was noted.

Table 1: Mean sensory scores for foxtail millet bran muffins

Variations	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability
FM0	8.00±0.55	8.10±0.94	7.62±1.40	8.00±0.71	7.71±1.10	7.71±1.15
FM10	7.81±0.87	7.86±1.01	7.48±1.21	7.57±1.12	7.71±0.78	7.67±1.02
FM15	7.33±0.80	7.62±0.80	7.43±0.98	7.62±1.02	7.62±1.02	7.29±0.96
FM20	7.71±0.64	7.76±0.62	7.24±1.37	7.48±1.17	7.62±0.97	7.52±1.17
FM25	7.67±0.91	7.62±0.74	7.62±1.32	7.33±1.20	7.24±1.14	7.24±1.30
FM30	8.00±1.00	7.81±0.93	7.90±1.00	7.90±1.18	7.90±1.26	7.95±1.12
SEm±	0.176	0.186	0.267	0.235	0.230	0.244
F-value	1.98	0.91	0.71	1.17	0.91	1.23
F-prob	0.085 ^{NS}	0.478 ^{NS}	0.618 ^{NS}	0.327 ^{NS}	0.473 ^{NS}	0.299 ^{NS}

Note: Values expressed as mean ± SD. FM: Foxtail bran muffin; 0, 10, 15, 20, 25, 30: percent bran incorporation. Means represented within same column having different alphabet show statistically significant difference at 5 %. NS indicates no significant difference within the treatments.

Table 2: Physical characteristics of foxtail millet bran muffins

Variations	Weight (g)		Height (cm)		Baking loss rate (%)
	Before baking	After baking	Before baking	After baking	
FM0	33.20 ± 0.45	29.60 ± 0.42	1.58 ± 0.08	3.46 ± 0.29	9.34 ± 0.72
FM10	33.10 ± 0.22	30.10 ± 0.89	1.56 ± 0.05	3.46 ± 0.05	9.34 ± 3.35
FM15	33.10 ± 0.22	30.00 ± 1.22	1.56 ± 0.05	3.34 ± 0.31	9.06 ± 1.83
FM20	33.40 ± 0.55	30.40 ± 0.42	1.56 ± 0.05	3.34 ± 0.31	8.95 ± 1.02
FM25	33.20 ± 0.45	30.40 ± 1.14	1.54 ± 0.05	3.38 ± 0.30	8.99 ± 3.01
FM30	33.10 ± 0.22	30.30 ± 0.67	1.58 ± 0.08	3.44 ± 0.15	8.76 ± 0.67
SEm±	0.191	0.383	0.029	0.115	0.925
F-value	0.373	0.645	0.262	0.247	0.061
F-prob	0.862 ^{NS}	0.668 ^{NS}	0.930 ^{NS}	0.937 ^{NS}	0.997 ^{NS}

Note: Values expressed as mean ± SD. FM: Foxtail bran muffin; 0, 10, 15, 20, 25, 30: percent bran incorporation. Means represented within same column having different alphabet show statistically significant difference at 5 %. NS indicates no significant difference within the treatments

**Fig. 1: Foxtail millet bran muffins**

CONCLUSION

From the results of the present study it was concluded that muffins developed with refined wheat flour replaced with 30% foxtail millet bran were acceptable. Sensory scores for all parameters indicate that commercialization of bran enriched muffins as healthy substitute for currently available muffins is possible. Considering the health benefits of foxtail millet bran and the results of present study it can be established that foxtail millet bran has

potential to be used as functional ingredient in bakery industry.

Acknowledgment

Authors would like to thank Millet Processing and Incubation Centre, PJTSAU for help throughout the study. Authors extend gratitude to the Professor Jayashankar Telangana State Agricultural University for all the facilities provided.

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