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Short Communication

Effect of the baking tray type on colour and sensory characteristics of horse-gram supplemented biscuits

Anuj Kumar*, Abhishek Kumar, Sunil Kumar, Ankush, Vanita Pandey, Om Prakash Gupta, Sewa Ram and Gyanendra Pratap Singh

ICAR-Indian Institute of Wheat and Barley Research, Karnal 132 001, India

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****Corresponding author:*** *E-mail: anuj19ak@gmail.com*

The sedentary lifestyle and upsurge in various non-communicable diseases have increased the consumer demand for healthy foods. Food researchers are constantly innovating formulations for combating these disorders. Biscuits are widely consumed bakery product because of their pleasant taste, convenience, and availability (Sudha *et al.,* 2007). Wheat flour is the major ingredient in most biscuit recipes. Though wheat flour contains 9-12% of protein, however lysine (an essential amino acid) content is limited (1.27-3.61 g/100g protein) (Siddiqui *et al.,* 2020). Thus, there is vast scope for incorporating nutritional functionality by manipulating the desired constituents of flour.

Horse gram is an underutilized legume with excellent nutritional properties and climatic resilience (Bhartiya *et al.,* 2015). This legume is also called a poor man's pulse in India. It contains protein (17–25%), carbohydrate (51.9–60.9%), minerals (2–3%) and dietary fibre (5–7%) (Vashishth *et al.,* 2022). The lysine content in horse gram is 6.84 g/ 100 g protein (Lalitha and Singh, 2020). Therefore, the addition of horse gram is expected to supplement the protein quantity and quality of wheat. Further, the consumption of horse gram is also known to enhance the antioxidant status of humans (Petchiammal and Hooper, 2014) and the treatment of kidney stones (Prasad and Singh, 2015). The anti-urolithic activity of the horse gram extract has also been observed by Vashisth *et al.* (2022).

Various researchers have successfully attempted to incorporate different protein-rich ingredients for biscuit formulation viz. sunflower seed flour (Grasso *et al.,* 2019), horse gram flour (Joshi and Awasthi, 2020), horse gram protein extract (Banerjee *et al.,* 2020), *Mucuna pruriens* (Singh and Singh, 2020), salmon hydrolysate (Singh *et al.,* 2020). Consequently, it has been noticed that the increased incorporation of protein-rich ingredients in biscuits may increase browning and decrease the colour and appearance scores. Browning reactions viz., Maillard reaction and caramelization occurring in the biscuits governs the colour of biscuits. Kumar *et al.* (2019) observed the higher intensity of these browning reactions in marine collagen peptide-enriched biscuits due to enhanced absorption/entrapment of heat by the baking sheet. During the baking, biscuit dough is placed in an oven and baked at a set time-temperature combination. The baking tray acts as the baking surface inside the oven. The bottom surface of the biscuits has been found to be darker in comparison to the top surface (Prakash *et al.,* 2018). The heat energy is transferred via radiation from the oven walls, via convection from heated air and by conduction from the tray surface to the product being baked (Baldino *et al.,* 2014). Usually, wire mesh bands and steel bands, both are utilized for baking-depending on the type of product being baked. The type of baking surface and the baking time are important factors affecting the final product quality (Caballero *et al.,* 2016). The rate of heat transfer at the bottom surface of the product is influenced by the type of tray utilized for baking, which subsequently may alter the colour of the product. Keeping this in consideration, it was aimed to study the effect of baking tray type on the colour and sensory characteristics of the horse gram-enriched biscuits.

Wheat flour utilized during the study was obtained after milling wheat variety DBW 296 while the horse gram (*Macrotyloma uniflorum*) (Aryavrat Organics, Jaipur, India) was procured locally, cleaned, germinated, dried, and milled into flour before usage. Germination is known to reduce the anti-nutritional components of horse gram (Pal et al., 2016). The other ingredients required for the biscuit preparation were purchased from the local market (Table 1). Accordingly, homogeneous biscuit dough was obtained by mixing the ingredients in a pin-type mixer (Widsons Scientific Works, Delhi) for 5-6 min along with 9 mL of water. The biscuit dough was rolled and shaped using a circular mould of 5.1 cm. The biscuits were baked at 180°C±5°C (Wiswo baking oven, Widsons Scientific Works, Delhi) for 16 min on trays (solid tray and mesh tray- wire -0.15 cm; 35 mesh/ sq. inch. Fig. 1).

The moisture content in the biscuit samples varied from 2-3%. The biscuits were then cooled to room temperature and packed in polyethene pouches until further study. Four sets of biscuits (BN: solid band normal; BL: solid band legume; MN: Mesh normal; ML: Mesh legume) obtained were analysed subsequently. Moisture content was determined gravimetrically by the oven drying method (Kumar *et al.,* 2019).

Table 1. The formula for biscuit preparation

Ingredients	Control biscuits (g)	Legume-supplemented biscuits (g)
Wheat flour	50	38
Legume flour	--	12
Sugar	15	15
Sunflower oil	15	15
Lecithin	0.25	0.25
Sodium bicarbonate	0.25	0.25
Ammonium bicarbonate	0.25	0.25
Common salt	0.25	0.25

The sensory evaluation of biscuits was carried out using five-panel members from the Division of Quality and Basic Sciences, ICAR-Indian Institute of Wheat and Barley Research, Karnal on a 9-point Hedonic scale. The following descriptors were used: colour- bottom surface, appearance- bottom surface, odour, taste and texture. The browning index of biscuits was determined as described by Kumar *et al.* (2016). The colour of biscuits was measured in terms of Hunter L*, a*, and b* values using a spectro-colourimeter (Colorflex EZ 45/0, HunterLab, USA). The spread ratio of biscuits was calculated as the quotient of the diameter and thickness of the biscuits measured using Vernier callipers.

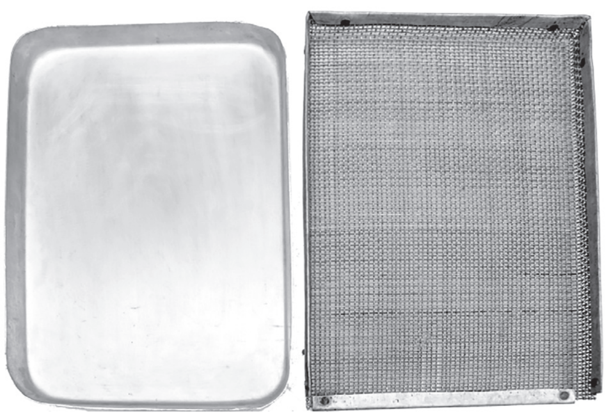

Fig.1. Solid band tray (left) and mesh tray (right)

Sensory evaluation is carried out to evaluate the food products for ensuring that the end user receives a quality product that appeals to the senses-meeting consumer expectations. It is important for carrying out research, product development and quality control (https://www.tentamus.com/lab-analyses/sensory-testing/). A perusal of sensory data elucidated using a radar diagram (Fig. 2), revealed the differences between the sensory attributes of biscuits baked on different trays. The sensory colour score and appearance score of the bottom biscuit surface varied from 4.67 to 7.50 and 4.83 to 7.67, respectively. The lowest score was obtained for legume biscuits baked on a solid band tray while the highest was for control biscuits baked similarly.

Akin to this, the legume-supplemented biscuits baked on the solid band tray scored least on the appearance score, followed by BN, ML and MN. The appearance score for the legume-fortified biscuits was disliked slightly by the sensory panellists.

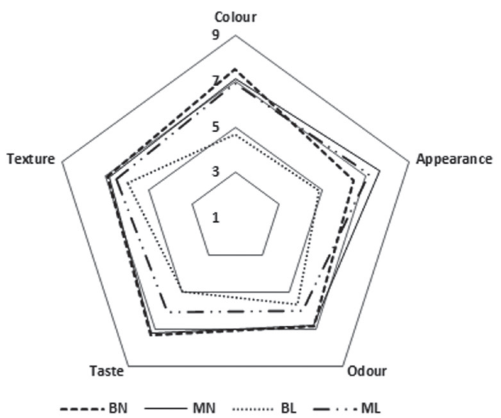

Fig. 2 Radar diagram depicting the sensory attributes of biscuits

As evident from Figure 3., the difference in colour and appearance of the biscuits is considerable. Baking on the solid band led to darker biscuits as compared to ones baked on the mesh. This might have occurred because of the enhanced browning process (Maillard browning and caramelization) near the bottom surface, possibly due to the entrapment of heat by the baking sheet (Kumar *et al.,* 2019). Increased temperature is linked to the increased formation of non-enzymatic browning compounds (Miranda *et al.,* 2009).

Kumar *et al.* (2019) further suggested that perforated or wire mesh trays may be utilized for baking to obtain uniform colour. Also, the biscuits baked on the solid bands suffered from the hollow bottoms. The hollow bottom defect on the biscuits generally happens due to the random incorporation of air during the mixing process which expands upon heating or uneven baking temperature in the oven. The biscuits baked on mesh were devoid of hollow bottoms implying a more uniform heat transfer while baking. Further to mention, the hollow bottom defect can also be seen in biscuits made with overworked dough.

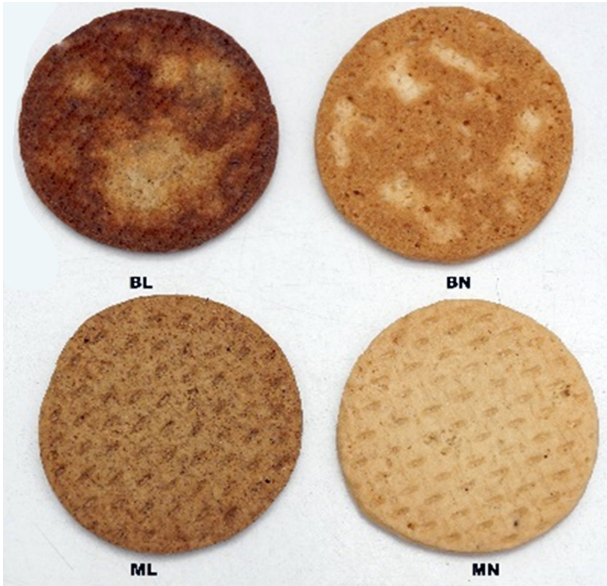

Fig. 3 Control and legume-supplemented biscuits baked on different trays

(BL: Band legume; BN: Band normal; ML: Mesh legume; MN: Mesh normal)

The other sensory attributes viz., odour, taste and texture scores for biscuits varied from 5.67 to 6.83, 5 to 7.33 and 6 to 6.92, respectively. The difference in the degree of browning arising due to baking in different trays might also impact the odour and taste of the product. In general, the legume-supplemented biscuits baked on the solid band tray scored less than those baked on the mesh tray for all sensory attributes. The brown discolouration in baked foods is due to the formation of various non-enzymatic browning products. The browning index effectively measures the discolouration of the product and measures the high molecular weight products formed during the browning process (Delgado *et al.,* 2010). The browning index of the biscuits varied from 0.563 to 0.937 (Fig. 4). BL samples were most brown followed by ML, BN and MN. As already mentioned, the browning intermediates produced during the course of baking might have caused the production of brown pigments. The increased browning was observed in the case of samples baked on the solid band in comparison to the samples baked on the mesh tray.

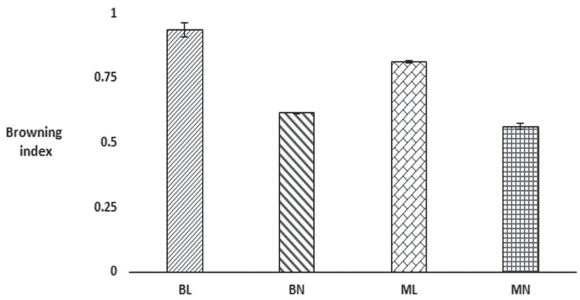

Fig. 4 Browning index of the biscuits

The colour of the samples measured in terms of Hunter L*, a* and b* also displayed similar results. L* value indicating the lightness varied from 46.72 to 68.74 while the a* value which indicates redness (positive value) and b* value which indicates yellowness (positive value) ranged from 6.68 to 11.34 and 27.00 to 30.35, respectively.

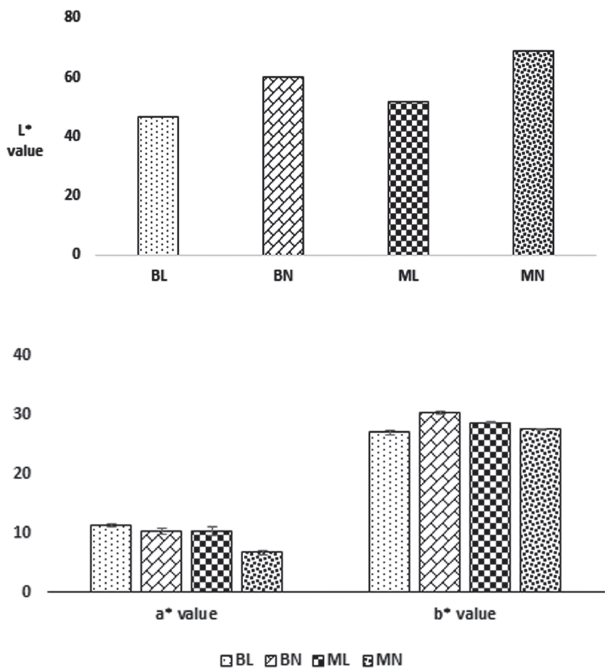

Fig. 5 Hunter colour values of the biscuits

The trend followed by L*, a* and b* colour values is as follows: BL<ML<BN<MN, MN<ML<BN<BL and BL<MN<ML<BN (Fig. 5). The spread ratio of the biscuits measured as the quotient of width and thickness varied from 8.25 to 9.75. The biscuits baked on the solid band tray had a higher spread ratio than the biscuits baked on the mesh tray. Further, the addition of horse gram flour also decreased the spread ratio of the biscuits. The biscuit flow generated during the baking got hindered due to the mesh structure which might have restricted the expansion and caused the reduction in the spread ratio.

Summary

Since horse gram contains a higher amount of protein, the addition is expected to have accentuated the protein and lysine content in biscuits. The type of baking tray affected the colour and sensory characteristics of the biscuits. Baking on a solid band sheet enhanced the browning thereby affecting the aesthetics of the biscuits while baking on a wire mesh tray caused a reduction in the browning and spread ratio of the biscuits.

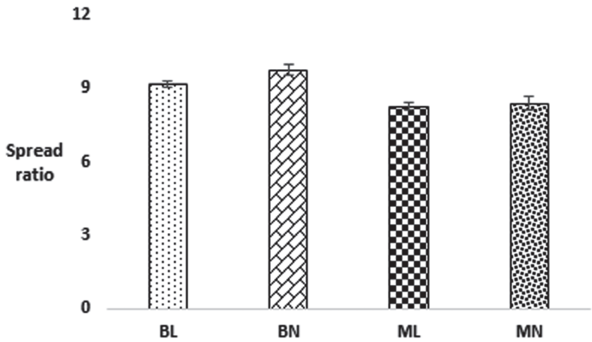

Fig. 6 Spread ratio of the biscuits

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Compliance with ethical standards

NA

Conflict of Interest

No

Author contributions

AK (Planning, execution and writing); AK (Execution); SK (Planning and editing); Ankush (Execution); VP (Planning and editing); OPG (Planning and editing); SR (Planning, editing and guidance) GPS (Planning and guidance)

References

1. Baldino N, D Gabriele, FR Lupi, B de Cindio and L Cicerelli. 2014. Modelling of baking behaviour of semi-sweet short dough biscuits. *Innovative Food Science and Emerging Technologies* 25: 40-52.

2. Banerjee S, S Haldar, N Reddy, R Reddy, GS Nagananda and J Mitra. 2022. Under-utilized germinated horse gram (*Macrotyloma uniflorum*) protein–Extraction, process optimization, characterization and its use in cookies fortification. *LWT* 160: 113276.
3. Bhartiya A, JP Aditya and L Kant. 2015. Nutritional and remedial potential of an underutilized food legume horse gram (*Macrotyloma uniflorum*): a review. *JAPS: Journal of Animal & Plant Sciences* 25: 908-920.
4. Caballero B, P Finglas and F Toldrá. 2016. *Encyclopedia of Food and Health.* Academic Press, Oxford.
5. Delgado-Andrade C, I Seiquer, A Haro, R Castellano and MP Navarro. 2010. Development of the Maillard reaction in foods cooked by different techniques. Intake of Maillard-derived compounds. *Food Chemistry 122:* 145-153.
6. Grasso S, Omoarukhe E, Wen X, Papoutsis K and L Methven. 2019. The use of upcycled defatted sunflower seed flour as a functional ingredient in biscuits. *Foods* 8: 305.
7. https://www.tentamus.com/lab-analyses/sensory-testing/; assessed on 8 September 2022
8. Joshi H and P Awasthi. 2020. Evaluation of physical properties and sensory attributes of biscuits developed from whole wheat flour supplemented with horse gram flour. *Journal of Pharmacognosy and Phytochemistry* 9: 1652-1656.
9. Kumar A, K Elavarasan, MD Hanjabam, PK Binsi, CO Mohan, AA Zynudheen and A Kumar. 2019. Marine collagen peptide as a fortificant for biscuit: Effects on biscuit attributes. *LWT 109*: 450-456.
10. Kumar A, P Ramakumar, AA Patel, VK Gupta and AK Singh. 2016. Influence of drying temperature on physicochemical and techno-functional attributes of elephant foot yam (*Amorphophallus paeoniifolius*) var. Gajendra. *Food Bioscience 16*: 11-16.
11. Lalitha N and SA Singh. 2020. Preparation of horse gram protein concentrates with improved protein quality, in vitro digestibility and available lysine. *Journal of Food Science and Technology 57:* 2554-2560.
12. Miranda M, H Maureira, K Rodriguez and A Vega-Gálvez. 2009. Influence of temperature on the drying kinetics, physicochemical properties, and antioxidant capacity of Aloe Vera (*Aloe Barbadensis* Miller) gel. *Journal of Food Engineering, 91*: 297-304.
13. Pal RS, A Bhartiya, R Arun Kumar, L Kant, JP Aditya and JK Bisht. 2016. Impact of dehulling and germination on nutrients, antinutrients, and antioxidant properties in horse gram. *Journal of Food Science and Technology* 53: 337-347.
14. Petchiammal C and W Hopper. 2014. Antioxidant activity of proteins from fifteen varieties of legume seeds commonly consumed in India. *International Journal of Pharmacy and Pharmaceutical Sciences* 6: 476-479.
15. Prasad SK and MK Singh. 2015. Horse gram-an underutilized nutraceutical pulse crop: a review. *Journal of Food Science and Technology* 52: 2489-2499.
16. Siddhuraju P and S Manian. 2007. The antioxidant activity and free radical-scavenging capacity of dietary phenolic extracts from horse gram (*Macrotyloma uniflorum* (Lam.) Verdc.) seeds. *Food Chemistry* 105: 950-958.
17. Siddiqi RA, Singh TP, Rani M, Sogi DS and MA Bhat. 2020. Diversity in grain, flour, amino-acid composition, protein profiling, and proportion of total flour proteins of different wheat cultivars of North India. *Frontiers in Nutrition* 7:141.
18. Singh A, S Benjakul and N Huda. 2020. Characteristics and nutritional value of biscuits fortified with debittered salmon (*Salmo salar*) frame hydrolysate. *International Journal of Food Science and Technology,* 55: 3553-3562.
19. Singh G and S Singh. 2020. Organoleptic evaluation of the product developed by using flour of an underutilized legume: *Mucuna* beans. *International Journal of Home Science* 6: 372-375.
20. Sudha ML, R Vetrimani and K Leelavathi. 2007. Influence of fibre from different cereals on the rheological characteristics of wheat flour dough and biscuit quality. *Food Chemistry 100:* 1365-1370.
21. Vashishth R, Semwal AD, Murugan MP, Khan M and C Goel. 2022. Influence of processing on bioactive compounds, Type-II diabetes-related enzyme regulation potential and anti-urolithiatic potential of underutilized legume *Macrotyloma uniflorum. Journal of Food Science and Technology* 59: 3220-3230.