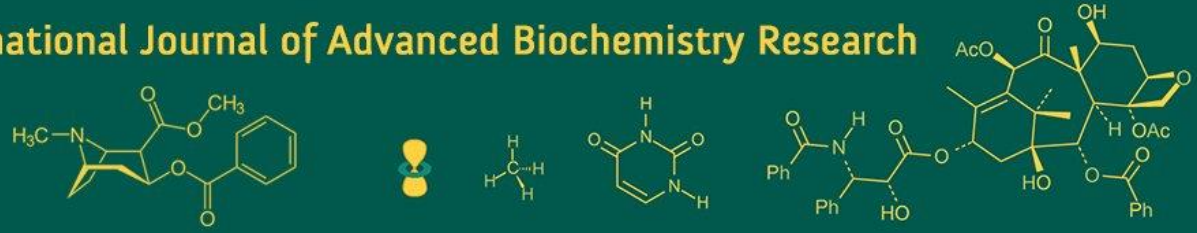
International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(10): 485-487
www.biochemjournal.com
Received: 02-07-2024
Accepted: 07-08-2024

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Sensory evaluation of biscuits enriched with composite flour of barnyard millet and dragon fruit powder

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DOI: https://doi.org/10.33545/26174693.2024.v8.i10g.2511

Abstract
This study investigated the sensory attributes of biscuits made from a composite flour of barnyard millet and dragon fruit powder, utilizing a 5-point hedonic scale. Key parameters evaluated included colour, taste, flavour, texture, appearance, and overall acceptability. Results revealed significant variations across treatments, particularly in colour, where treatment T_{10} achieved the highest score (4.93), while treatment T_1 recorded the lowest (1.07). The colour of the biscuits was influenced by the concentration of dragon fruit powder (DFP), with higher levels resulting in darker shades that were less favoured by panellists. For taste and flavour, treatment T10 also excelled, scoring 4.93 and 4.87, respectively, demonstrating the positive effect of DFP on these attributes. Texture analysis indicated that T_{10} scored 4.93, reflecting a desirable mouthfeel. Additionally, T_{10} received the highest appearance score (5.00), attributed to the vibrant colour provided by the β-cyanins in dragon fruit. Overall acceptability confirmed these trends, with T_{10} leading at 5.00, highlighting the advantageous incorporation of dragon fruit powder in enhancing the sensory qualities of the biscuits. The bioactive compounds present in dragon fruit contributed to improved sensory attributes, underscoring its potential in baked goods. These findings emphasize the feasibility of using composite flours to produce appealing and nutritious biscuit products.

Keywords: Sensory attributes, biscuits, composite flour, barnyard millet, dragon fruit powder

Introduction
Biscuits are popular snacks typically made from flour, water, fat, and sugar, with wheat flour being the primary ingredient due to its gluten content. They are cost-effective, have a long shelf life, and come in various sizes and Flavors. Dragon fruit powder serves as a versatile natural colorant and functional ingredient, benefiting from spray drying, which converts fruit juices into nutrient-rich powders that are easy to transport. However, issues like stickiness can arise, which can be mitigated with carrier materials (Kha *et al*., 2010; Tonny *et al*., 2008) [4, 9]. Barnyard millet (*Echinochloa frumentacea*) is a nutrient-dense grain, high in protein and fibre, and low in digestible carbohydrates, making it beneficial for metabolic disorders like diabetes (Ugare *et al*., 2014) [10]. Its incorporation, along with dragon fruit flour and peel pectin, can enhance the nutritional profile of biscuits. Baked goods, including biscuits, are favoured for their convenience, low moisture content, and reduced spoilage risks, enabling large-scale production (Vijaykumar *et al*., 2013; Dhankar, 2013) [11, 2]. Efforts are underway to improve the nutritional quality of biscuits to meet the growing demand for healthier snack options (Masoodi and Bashir, 2012) [7]. They are prepared by mixing ingredients into a dough and baking without fermentation (Lake and Water-Worth, 1980) [5].

Materials and Methods
Sensory evaluation of biscuits
The sensory characteristics were done on the basis of colour, flavour, taste, texture and overall acceptability of biscuits and evaluation has done in the 5 point hedonic rating scale **(**Dragomir *et al.,* 2020) [3]. Organoleptic evaluation was carried out by two trials. Each trial was evaluated by the Pannel of 10 members of P.G students. Each Pannel member was provided with the five-point hedonic scale score card (scale: 1-dislike extremely; 2-dislike slightly; 3-neither like nor dislike; 4-like slightly; 5-like extremely).

Results and Discussion

Sensory evaluation of biscuits (5- points' hedonic scale)

1. Colour

Colour appears to be the important element for initial acceptability of baked product by consumers. The data regarding colour of the biscuits produced from composite flour of barnyard millet and dragon fruit powder is presented in the Table 1.

Colour variation was observed in biscuits those prepared with different composition of dragon fruit powder and barnyard millet. Among the treatments T_{10} (4.93) recorded maximum score in 5- points' hedonic scale but at par with T_{11} (4.87), T_9 (4.80) followed by T_8 (4.27), T_7 (3.87) and minimum score was recorded in treatment T_1 (1.07) but at par with T_2 (1.20). The colour was decreasing with increasing level of DFP. This was due to the increasing level of DFP which gave a dark brown colour to the biscuit which was not preferred by the panellists. However, biscuits incorporated up to 50% level of DFP were acceptable to panel, a similar effect was observed by Sengkhamparn, N. *et al.* (2013) [8].

Table 1: Sensory evaluation score of the biscuits prepared from composite flour of barnyard millet and dragon fruit powder

Treatment	Colour	Taste	Flavour	Texture	Appearance	Overall acceptability
T_1 100:0 (BYMF+DFP)	1.07^{g}	1.13^{h}	1.07^{i}	1.00^{f}	1.07^{h}	1.07^{h}
T_2 95:5 (BYMF+DFP)	1.20^{fg}	1.20^{h}	1.27^{h}	1.07^{f}	1.13^{h}	1.13^{h}
T_3 90:10 (BYMF+DFP)	1.33^{f}	1.53^{g}	2.13^{g}	2.87^{e}	2.60^{g}	2.87^{g}
T_4 85:15 (BYMF+DFP)	3.27^{e}	2.60^{f}	3.13^{f}	3.27^{d}	3.07^{f}	2.73^{g}
T_5 80:20 (BYMF+DFP)	3.33^{e}	3.20^{e}	3.53^{e}	4.00^{c}	4.20^{d}	3.47^{f}
T_6 75:25 (BYMF+DFP)	3.53^{d}	3.53^{d}	3.47^{e}	4.00^{c}	3.93^{e}	3.67^{e}
T_7 70:30 (BYMF+DFP)	3.87^{c}	4.07^{c}	3.87^{d}	4.33^{b}	4.20^{d}	4.00^{d}
T_8 65:35 (BYMF+DFP)	4.27^{b}	4.20^{c}	4.20^{c}	4.47^{b}	4.87^{ab}	4.20^{c}
T_9 60:40 (BYMF+DFP)	4.80^{a}	4.60^{b}	4.67^{b}	4.87^{a}	4.67^{c}	4.47^{b}
T_{10} 55:45 (BYMF+DFP)	4.93^{a}	4.93^{a}	4.87^{a}	4.93^{a}	5.00^{a}	5.00^{a}
T_{11} 50:50 (BYMF+DFP)	4.87^{a}	4.67^{b}	4.73^{ab}	4.87^{a}	4.73^{bc}	4.60^{b}
Mean	3.32	3.24	3.36	3.61	3.59	3.38
S.E.m.±	0.05	0.05	0.06	0.05	0.06	0.05
C.D. 5%	0.16	0.14	0.18	0.16	0.19	0.14
C.D. 1%	0.22	0.19	0.24	0.21	0.26	0.19

Colour development of baked products is caused by Maillard reactions between sugars and proteins (Lingnert, 1990) [6]. The Maillard reaction is a non-enzymatic reaction which causes the formation of melanoidins. Others factors that might contribute to the colour of final products were ingredients' composition, time of baking (Cronin and Preis, 2000) [1]. The humidity in the oven and atmosphere in the early stages of baking also affected the development of final colour (Wade, 1988) [13].

2. Taste

The data regarding taste of the biscuits produced from composite flour of barnyard millet and dragon fruit powder is presented in the Table 1.

Among the treatments, T_{10} (4.93) recorded highest score in 5- points' hedonic scale followed by T_{11} (4.67) T_9 (4.60), T8 (4.20) and minimum score was recorded in treatment T_1 (1.13) but at par with T_2 (1.20).

3. Flavour

The data regarding flavour of the biscuits produced from composite flour of barnyard millet and dragon fruit powder is presented in the Table 1.

Among the treatments, T_{10} (4.87) recorded highest score in 5- points' hedonic scale, but was at par with T_{11} (4.73), followed by T_9 (4.67), T_8 (4.20) and minimum score was recorded in treatment T_1 (1.13). The flavour of biscuits slightly improved with increasing DFP as these biscuits had mild Kiwi-ish flavour.

4. Texture

The data regarding texture of the biscuits produced from composite flour of barnyard millet and dragon fruit powder is presented in the Table 1.

Among the treatments, T_{10} (4.93) recorded highest score in 5- points' hedonic scale, but was at par with T_{11} (4.87), T_9 (4.87) followed by T_8 (4.47) and minimum score was recorded in treatment T_1 (1.00).

5. Appearance

The data regarding appearance of the biscuits produced from composite flour of barnyard millet and dragon fruit powder is presented in the Table 1.

Among the treatments T_{10} (5.00) recorded maximum score in 5- points' hedonic scale followed by T_8 (4.87), T_{11} (4.73), T_9 (4.67) and minimum score was recorded in treatment T_1 (1.07).

6. Overall acceptability

The data regarding overall acceptability of the biscuits produced from composite flour of barnyard millet and dragon fruit powder is presented in the Table 1.

Among the treatments T_{10} (5.00) recorded maximum score in 5- points' hedonic scale followed by T_{11} (4.60), T_9 (4.47), T_8 (4.20) and minimum score was recorded in treatment T_1 (1.07).

Dragon fruit powder incorporation is a unique and impart vibrant appearance which is attributed to the presence of ß-cyanins and presence of significant number of bioactive compounds exhibited increased sensory attributes present in the dragon fruit pertaining to taste, texture, flavour and overall acceptability score.

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