



Chemical and Organoleptic Study of Micro Green Based Functional Biscuits

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To study about functional foods and their importance to overcome malnutrition. Functional foods and their derivatives: they are not considered as medicines, so they do not have therapeutic effects on health. Bakery items, such as biscuits, are widely available and consumed by a large number of people in many countries, making them a viable supplementation vehicle for nutritional security.

Methodology: The goal of the study was to designed and manufactured micro green-based biscuits by replacing refined wheat flour with micro green (Spinach) to combat malnutrition from a low-cost source as baked product for people at various levels (at 0, 05, 10, 15, 20 and 25 percent).

Results: In terms of sensory qualities, the biscuits made with 90% refined wheat flour and 10% micro green (T3) were definitely the most palatable. Treatment T1 had the highest levels of CHOs, crude fat, fibre, protein, phosphorus, Iron and energy, while treatment T2 had the highest levels of ash, calcium, and moisture.

Conclusion: Microgreens may prove to be a cost-effective and acceptable substitute for refined wheat flour in biscuit baking.

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1. INTRODUCTION

Food is essential for human beings. People have different taste of it and different food habits depending upon their religion, ethnic, geographical, climatic, seasonal, educational, economical situations (K.C., 2007). Baking has the primeval of the oldest arts which has a remote past and undoubtedly has a distant future. It is hard to imagine a world evolving in which bakery does not play a part (Cauvain, 2003).

Biscuits and many bakery products are widely assorted and consumed by numerous people in many countries and therefore it offers a relevant supplementation vehicle for nutritional security (Arshad et al., 2007). Alteration to the basic recipes and addition of few novel ingredients such as fat replacers, fibres, cereals than wheat, etc. had led to a new biscuit combination with advanced nutritive as well as functional value (Handa et al., 2012; Yadav et al., 2012).

Functional foods and their derivatives: they are not considered as medicines, so they do not have therapeutic effects on health. The principal role of these foods in relation to the disease and disorder is, in the vast part of cases, to conquer the hazard of occurrence rather than prevent from them. (Eed AM and Burgoyne AH, 2015).

Wheat is the important and staple food of the people in India and around the globe because of fundamental source of energy and nutrients. It contains moisture 12.8%, protein 11.8%, fat 1.5%, minerals 1.5%, crude fibre 1.2%, carbohydrates 71.2%, Energy value 346 Kcal, Calcium (Ca) 41mg/100g, Phosphorus (P) 306 mg/100g and Iron (Fe) 5.3 mg/100g respectively (Gopalan et al., 1989).

Microgreens contains giant levels of vitamin E and rich concentration of ascorbic acid, carotenoids, Phylloquinone, and tocopherols. Asteraceae microgreens, such as chicory and lettuce, turn out to be high in vitamin A, or carotenoids antioxidants. They are consumed as to ameliorate salads, or as edible garnishes to embellish a huge range of other dishes. (Xiao et al., 2012).

Sprouting of is a good method to enhance the physical, nutritional and nutraceutical traits of cereals since the technique is simple,

inexpensive, boost the availability of various nutrients and significantly reduces anti-nutritional factors (Cevallos Casals and Cisneros-Zevallos, 2010).

The Composite flour technology/blending of cereal flour with legumes/leafy vegetables viable option to overcome malnutrition in the country. And it is examined advantageous in several it benefits developing countries by reducing wheat flour imports and encouraging the use of locally produced food as flour. (Hugo et al., 2000; Hasnadi et al., 2014).

2. METHODS

The present investigation was undertaken on "Chemical and organoleptic study of micro green based functional biscuits" at MGCGVV, Chitrakoot, Satna (M.P.), INDIA.

2.1 Experimental Materials

The wheat and micro green were procured from the local market and all other ingredients (sugar, vegetable oil, glucose, ammonium bicarbonate, common salt sodium bicarbonate, vanilla and baking powder) were purchased from the retail market and department. The materials were transported to department.

2.2 Preparation of Biscuits through Selected Wheat Sprouted Grains and Microgreens

2.2.1 Processing of grains

The grains (wheat) were washed and cleaned to remove the dirt, dust and foreign matter by winnowing.

2.2.2 Sprouting process

Wheat grains were sprouted as described by (Murugkar, 2014).

2.3 Development and Optimization of Baked Products (Biscuits)

First of all, studies were conducted to standardize the formulation for the development of the different cereal-pulses based baked products (biscuits). Biscuits were processed using the traditional creamery method described by Whitley (1970).

2.4 Physical and Functional Properties

Bulk Density: - The bulk densities of biscuits were analyzed as per Wang and Kinsella (1976). **Water absorption capacity (WAC):** - Water absorption capacity (WAC) of flour was determined by the method given by Sosulski et al., (1976).

Diameter (D): - The Diameter of biscuits was measured by the prescribed method (AACC, 2000).

Thickness (T): - Thickness was measured by Vernier calliper as per (Jauharah et al., 2014).

Spread factor (D/T): - The spread factor was calculated by (AACC, 2000).

Weight (W): - Ten pieces average weights (W) of both samples were recorded (Jauharah et al., 2014).

Proximates value: - Moisture: - Moisture was analyzed using the MBS4 moisture analyzer at 100°C for 10 minutes.

Protein, Fat, Carbohydrates and Ash content in the sample was estimated by the procedure indicated in the AOAC (1984).

Estimation of Minerals: - Minerals content of cookies were estimated through the Gopalan table values (Gopalan et al., 1989).

Calorific Value: -The total energy values were estimated with using the values of 4, 4, and 9 for protein, carbohydrate and fat respectively as follows: Total calorie (kcal/100g) = [(% available carbohydrates X4) + (% protein X4) + (% fat X9)].

Sugars: - The sugars content (Reducing, non-reducing and total sugar) of the sample was determined by the procedure as indicated by Ranganna (2012).

Amylose: - The amylose content was estimated according to method as described by Sadasivam and Manickam (1992).

2.5 Organoleptic Value

The organoleptic qualities of nutritious cookies were evaluated by a nine-point hedonic scale as indicated by the Amerine et al. (1965).

2.6 Statistical Analysis

The data were subjected to analysis of variance (ANOVA). The Completely Randomized Design (CRD) at 5% level of significant. And mean values of two years (2017-2018) pooled data were used to analyze statistically.

3. RESULTS AND DISCUSSION

3.1 Physical Analysis of Wheat and Micro Green Biscuit were Depicted in Table 3

Weight: - It was evident that the weight and MG based biscuit varied from 48.70 to 61.88 g of 10 biscuits. The highest weight of the biscuit was found in T4 (61.88 g) whereas lowest in T2 (48.70 g). Decrease in the weight was due to supplementation of micro green flour in biscuit. Similar work was carried out by Akapapunam and Darbe, (1994) in the study if groundnut maize flour. **Diameter:** -The diameter of the biscuit prepared from wheat and micro green ranged from 43.87 to 45.74 mm. The highest diameter was found in combination T4 (45.74 mm) whereas lowest diameter in T2 (43.87 mm) as per Mamat et al., (2010). **Bulk density:** -The BD of the wheat and MG based biscuit varied from 0.69 to 0.72 g/ml with increased level of MG. BD of the biscuit was found maximum in combination T2 (0.72 g/ml) whereas lowest weight of the biscuit was found in combination T6 (0.69 g/ml). Similar results were reported by Jyoti and Jood (2020). **Thickness:** - Biscuit of wheat and MG had thickness varied from 4.31 to 4.75 mm. The highest thickness was found in combination T6 (4.75 mm) whereas lowest thickness was found in combination T2 (4.31 mm). Mamat et al., (2010) reported similar work and values ranged from 5.41 to 6.23 mm. **Spread factor (ratio):** -SF of biscuit prepared from wheat and micro green ranged from 9.63 to 10.59. The highest thickness was found in combination T2 (10.59) whereas lowest thickness was found in combination T5 (9.63). This was due to addition of wheat and MG in biscuit Oomah, (1983) reported that biscuits spread factor increased with increasing amount of roller milled oat flour. **Water absorption capacity (WAC):** - The wheat and MG supplemented biscuits ranged from 127.0 to 143.00 per cent. It was cleared from the values that the WAC was raised as mixing with different extent of ragi flour were presented in Table 3. Similar observation has also been made by Selvaraj and Shurpalekar (1982).

3.2 Proximate Composition of Wheat and Micro Green Biscuits

Moisture content: - The moisture per cent ranked from 4.20 to 5.40 % with increased level of micro green. Moisture content was highest in combination T4 (5.40%) whereas lowest was

found in combination T3 (4.20%). This was due to high fibre content in micro green as in comparison to wheat flour which has highest capacity to retain moisture. Similar findings were reported by Ganorkar and Jain (2014) in biscuits was presented in Table 4. **Carbohydrates (CHOs) content:** - T1 was found to have the highest CHOs content in the wheat and MG based biscuits combination (65.32 percent). CHOs content in wheat and MG based biscuits ranged from 49.62 to 62.20 percent. Decrease in carbohydrates might be due to the incorporation of hydrocolloids and increase in fat content of biscuits. The outcome was in agreement with Gambus et al., (2007) and Galla et al., (2017). **Protein percent:** - Protein content in wheat and MG based biscuits ranged from 9.34 to 11.46 percent. The protein % found higher in combination T2 (11.46%) whereas lowest in combination T6 (9.34%) in 90 days storage period were presented in Table 4. It can be also seen from table that incorporation of micro green in biscuits decrease protein content of the biscuits might be due to high amount of minerals content in micro green flour. Similar results of protein content of wheat and microgreens were in good accordance with the results obtained by Jyoti and Jood (2020). **Fat percent:** -The fat content of wheat and MG based biscuits ranged from 1.39 to 1.61 percent. The fat content was higher in combination T2 (1.61%) whereas lowest ash content was found to be in combination T6 (1.39%) in 90 days' time of storage were expressed in Table 4. The rise in the ratio of wheat and MG in biscuits significantly decreases the fat content of the biscuits. Results were also supported by the findings of other works by Galla et al., (2017). **Fibre content:** - The fibre content of wheat and GG-based biscuits ranged from 2.44 to 2.93 percent. In 90 days of ST, the highest fibre content was found in combination T2 (2.93%), while the lowest fibre content was found in combination T6 (2.44%) were depicted in Table 4. Addition of micro green in biscuits decreased fibre content of the biscuits due to high amount of minerals content in micro green flour and similar findings were reported by Jyoti and Jood (2020). **Ash content:** - The ash level of wheat and MG based biscuits ranged from 1.83 to 2.82 percent. The ash content was higher in combination T6 (2.82%) whereas lowest ash content was found to be in combination T2 (1.83%) in 90 days storage period were presented in Table 4. The ash level of biscuits is dramatically increased as the quantity of wheat and MG in the biscuits increases and values

were in accordance of the work of Galla et al., (2017). **Energy value content:** - The EV of wheat and MG based biscuits ranged from 250.29 to 310.53 Kcal. Combination T6 had a greater EV (335.67 Kcal), while combination T2 had the lowest 125 EV (250.29 Kcal). In 90 days storage time were expressed in Table 4. The increase in the level of wheat and micro green flour in the biscuits significantly decreases the energy value of the biscuits. Similar results were found in Jyoti and Jood (2020) and Galla et al. (2017). **Calcium content:** - Ca content in wheat and MG based biscuits ranged from 23.72 to 33.02 mg. In the 90-day storage period, the Ca concentration was greater in combination T6 (33.02 percent), whereas the lowest Ca level was discovered in combination T2 (23.72 percent) were presented in Table 4. It can be also from table that addition of micro green in biscuits increase Ca content of the biscuits might be due to high amount of minerals content in micro green our results support the findings of Galla et al. (2017). **Phosphorous (P) content:** - The phosphorus content of wheat and MG based biscuits ranged from 89.31 to 107.87mg. In the 90-day storage period, the highest phosphorous concentration was discovered in combination T2 (107.87 mg), while the lowest phosphorous content was found in combination T6 (89.31 mg) were presented in Table 4. Supplementation of micro green in biscuits decrease phosphorous content of the biscuits might be due to high amount of minerals content in micro green. Similar finding was given by Jyoti and Jood (2020). **Iron (Fe) content:** -Wheat and MG based biscuits ranged from 2.15 to 2.44 mg of Fe content. The Fe content was higher in combination T6 (2.44 mg) whereas lowest Fe content was found in combination T2 (2.15 mg) in 90 days storage period were presented in Table 4. Incorporation of MG in biscuits decrease Fe content of the biscuits might be due to high amount of minerals content in micro green. Similar results of Fe content of wheat and green gram flour were in good compatibility with the results obtained by Joel et al., (2014). **Reducing sugar:** -The wheat and MG added biscuits varied from 3.81 to 4.63 % and there were significant differences between each combination were presented in Table 4. Similar finding was given by Prabhavathi et al., (1973) reported that biscuits containing 4.3 per cent of reducing sugar. **Non-reducing sugar:** -The wheat and MG supplemented biscuits ranged from 0.72 to 1.06 per cent and there were significant differences between each

combination were presented in Table 4. Similar finding was given by Prabhavathi et al., (1973) reported a lower value of non-reducing sugar (3.40%) in wheat legume composite biscuits. **Total sugar:** -The wheat and MG supplemented biscuits ranged from 4.79 to 5.36 per cent and there were significant differences between each combination were presented in Table 4. Similar finding was given by Prabhavathi et al., (1973)

reported a lower value of total sugar (4.91%) in wheat legume composite biscuits (Hosamani et al., 2016). **Amylose content:** - The amylose content of biscuits was ranged from 10.42 to 17.14 per cent. In wheat and microgreens biscuits amylose content was maximum in T1 (13.95%) whereas minimum T6 (10.42%) and similar work in bakery products were undertaken by Giuberti et al., (2015).

Table 1. Preparation and development of sprouted wheat and micro green biscuits

S.N.	Treatments	Wheat	Micro green
1.	T1	100	-
2.	T2	95	5
3.	T3	90	10
4.	T4	85	15
5.	T5	80	20
6.	T6	75	25

Table 2. Total sugar, reducing, non-reducing and amylose % of sprouted wheat and micro green biscuits

Treatments	Reducing sugar	Non-reducing sugar	Total sugar	Amylose
T1	4.34	0.72	5.05	13.95
T2	3.81	0.99	4.79	13.76
T3	4.01	1.06	5.07	12.97
T4	4.60	0.77	5.36	12.67
T5	4.63	0.74	5.37	11.49
T6	4.13	1.03	5.16	10.42
Sem±	0.287	0.0392	0.274	0.67
CD at 5%	0.837	0.114	0.800	1.96
CV (%)	11.68	7.69	9.25	9.29
Sig	S	S	NS	S

Table 3. Physical parameter of the wheat and micro green biscuit

Treatments	Weight (in g of 10 Biscuits)	Diameter (mm)	Bulk density (g/ml)	Thickness (mm)	Spread Ratio	WAC%
T1	60.02	41.37	0.72	4.50	9.64	124.00
T2	48.70	43.98	0.72	4.31	10.59	127.00
T3	54.78	43.87	0.71	4.52	10.10	136.00
T4	61.88	45.74	0.70	4.74	10.06	135.50
T5	61.36	44.10	0.70	4.73	9.63	141.50
T6	59.37	44.37	0.69	4.75	9.72	143.00
Sem±	0.479	0.63	0.016	0.16	0.29	0.032
CD at 5%	1.475	1.949	0.048	0.479	0.890	0.100
CV (%)	1.438	2.496	3.829	5.869	5.024	0.042
Sig	S	S	S	S	S	S

Table 4. Proximate composition in % of wheat and MG biscuits

Treatments	Carbohydrates	Protien	Fat	Fibre	EV	Ash	Ca	P	Fe	Moisture
T1	65.80	12.11	1.67	3.12	328.05	1.52	21.57	113.45	2.54	3.25
T2	62.65	11.57	1.62	3.03	312.82	1.85	23.92	108.80	2.48	4.45
T3	59.50	11.04	1.57	2.88	297.63	2.11	26.27	104.09	2.41	4.20
T4	56.39	10.52	1.51	2.73	282.45	2.39	28.65	99.38	2.37	5.40
T5	53.21	10.01	1.46	2.59	267.27	2.61	30.97	94.68	2.27	4.30
T6	50.03	9.50	1.42	2.46	252.10	2.84	33.29	89.99	2.18	4.25
Sem±	0.082	0.080	0.082	0.071	0.069	0.065	0.071	0.070	0.068	0.016
CD at 5%	0.251	0.247	0.252	0.219	0.214	0.201	0.218	0.215	0.210	0.048
CV (%)	0.244	1.288	9.192	4.392	0.041	0.086	0.446	0.119	4.976	0.629
Sig	S	NS	S	S	S	S	S	S	S	S

Table 5. Sensory score of the wheat and MG biscuits

Treatments	Appearance	Colour	Crispiness	Taste	Texture	Overall acceptability
T1	7.55	8.0	7.85	7.35	8.00	7.84
T2	7.45	8.10	7.70	7.25	6.95	7.52
T3	8.25	8.35	7.95	7.40	7.95	8.07
T4	7.35	7.30	7.90	8.30	7.95	7.66
T5	7.80	7.25	7.25	8.20	7.25	7.40
T6	7.40	7.45	7.75	7.05	7.70	7.60
Sem±	0.040	0.030	0.025	0.026	0.023	0.032
CD at 5%	0.125	0.092	0.076	0.081	0.071	0.098
CV (%)	0.917	0.670	0.556	0.600	0.522	0.718
Sig	NS	NS	NS	NS	NS	NS

3.3 Sensory Score of Combination of the Wheat and Micro Green Biscuit

Appearance: -Sensory score depicted in Table 5 that Combination T1 had the highest sensory scores for appearance in wheat-based biscuits (7.60). In terms of appearance, sensory scores for wheat and MG based biscuits varied from 6.75 to 7.60. Combinations T5 and T6 (7.60) had the most prominent look, whereas combination T4 had the least prominent appearance (6.75). In wheat-based biscuits, appearance was found largely equal. It was due to Maillard reaction between sugar and proteins as accorded by Raidl and Klein, (1983) and Hussain et al., (2006). These results were found in accordance with Hooda and Jood, (2005).

Colour: - Colour sensory ratings ranged from 7.45 to 7.95 for wheat and MG based biscuits. The greatest colour was discovered in combination T2 (7.95), while the smallest colour was discovered in combination T4 (7.45). The colour of wheat-based biscuits was found substantially higher. It was due to Maillard reaction between sugar and proteins as accorded by Raidl and Klein, (1983) and Hussain et al., (2006). These results were found in accordance with Hooda and Jood, (2005).

Crispiness: - Crispiness scores for wheat and MG based biscuits ranged from 7.45 to 8.00. The highest crispiness was discovered in combination T3 (7.95), while the lowest crispiness was reported in combination T6 (7.45). Wheat-based biscuits were found to have much higher crispiness. Results were also supported by the findings of Hooda and Jood, (2005) and Hussain et al., (2006). **Taste:** - Combination T1 had the highest sensory scores for taste in wheat-based biscuits (6.95). The sensory scores for wheat and MG-based biscuits varied from 6.65 to 7.55. Combination T5 (7.55) had the highest maximum flavour, while combination T2 had the lowest

minimum taste (6.65). Taste was found significantly lower in wheat-based biscuit. These results were found in accordance with Hooda and Jood, (2005) and Hussain et al., (2006).

Texture: - Sensory scores of wheat and MG based biscuit ranged from 7.05 to 8.05 in texture. Maximum texture was found in combination T3 (8.05) whereas minimum texture was found in combination T4 (7.05). Texture was found significantly lower in wheat-based biscuit. Results were supported by Hooda and Jood, (2005) and Hussain et al., (2006). Among all the combinations containing different proportions of GG flour, T3 combination had appearance, crispiness and texture. Sensory score showed that the T3 was regarded as the best combination.

Overall Acceptability (OA): - OA scores for wheat and MG-based biscuits ranged from 7.35 to 7.77. The combination with the highest OA was T3 (7.77), while the combination with the lowest OA was T4 (7.35). Wheat-based biscuits were shown to have much higher OA. These results have close agreement to work of Chandra et al., (2015).

4. CONCLUSION

The research was carried out to determine the appropriate percentage of refined wheat and microgreens to use in the biscuit formulation. In terms of acceptability, the biscuits with 10% Microgreens performed best when compared to the other proportions. Microgreens can be included up to 10% in large-scale biscuit manufacturing without compromising the sensory features of the biscuits, according to the panellists. Furthermore, the nutritional value of Microgreens-infused biscuits was comparable to that of control biscuits (refined wheat flour). As a result, microgreens may prove to be a cost-effective and acceptable substitute for refined wheat flour in biscuit baking.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that no generative AI technologies such as Large Language Models (ChatGPT) etc. used in manuscript.

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MGCGV and JNKVV along with KVK performed the study and carried out the findings.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- AACC. (2000). *Approved methods of the American Association of Cereal Chemists* (10th ed.). St. Paul, MN, USA: AACC.
- Akpanunam, M. A., & Darbe, J. W. (1994). Chemical composition and functional properties of blends of maize and *Vigna subterranea* (bambara groundnut) flours for cookie production. *Plant Foods for Human Nutrition*, 46, 147–155.
- Amerine, M. A., Pangborn, R. M., & Rosseier, E. B. (1965). *Principles of sensory evaluation of food*. London, UK: Academic Press.
- AOAC. (1984). *Official methods of analysis* (14th ed.). Washington, DC: Association of Official Agricultural Chemists.
- Arshad, M. U., Anjum, F. M., & Zahoor, T. (2007). Nutritional assessment of cookies supplemented with defatted wheat germ. *Food Chemistry*, 102, 123–128.
- Cauvain, S. P. (Ed.). (2003). Introduction. In *Bread making: Improving quality* (p. 6). New York, NY: CRC Press.
- Cevallos-Casals, B. A., & Cisneros-Zevallos, L. (2010). Impact of germination on phenolic content and antioxidant activity of 13 edible seed species. *Food Chemistry*, 119, 1485–1490.
- Chandra, S., Singh, S., & Kumari, D. (2015). Evaluation of functional properties of composite flours and sensorial attributes of composite-flour biscuits. *Journal of Food Science and Technology*, 52(6), 3681–3688.
- Eed, A. M., & Burgoyne, A. H. (2015). Tissue culture of *Simmondsia chinensis* (Link) Schneider. *Banat's Journal of Biotechnology*, 6(11), 45–53.
- Galla, N. R., Pamidighantam, P. R., Math, B. K., Gurusiddaiah, R., & Akula, S. (2017). Nutritional, textural and sensory quality of biscuits supplemented with spinach (*Spinacia oleracea* L.). *International Journal of Gastronomy and Food Science*, 7, 20–26.
- Gambus, H., Sikora, M., & Ziobora, R. (2007). The effect of composition of hydrocolloids on properties of gluten-free bread. *Acta Scientiarum Polonorum, Technologia Alimentaria*, 6(3), 61–74.
- Ganorkar, P., & Jain, R. (2014). Effect of flaxseed incorporation on physical, textural, sensorial and chemical attributes of cookies. *International Food Research Journal*, 21(4), 1515–1521.
- Giuberti, G., Fortunati, P., Cerioli, C., & Gallo, A. (2015). Gluten-free maize cookies prepared with high-amylose starch: In vitro starch digestibility and sensory characteristics. *Journal of Nutrition & Food Sciences*, 5(6), 1-5.
- Gopalan, C., Rama Sastri, B. V., & Balasubramanian, S. C. (1989). *Nutritive value of Indian foods* (pp. 47–48). India: National Institute of Nutrition, Indian Council of Medical Research.
- Handa, C., Goomer, S., & Siddhu, A. (2012). Physico-chemical properties and sensory evaluation of fructooligosaccharide-enriched cookies. *Journal of Food Science and Technology*, 49(2), 192–199.
- Hasmadi, M., Siti Faridah, A., Salwa, I., Matanjun, P., Abdul H. M., & Rameli, A. S. (2014). The effect of seaweed composite flour on the textural properties of dough and bread. *Journal of Applied Phycology*, 26, 1057–1062.
- Hooda, S., & Jood, S. (2005). Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. *Food Chemistry*, 90, 427–435.
- Hosamani, R., Jagadeesh, S., & Suresha, G. (2016). Fortification of carrot, jackfruit and aonla powder to enhance nutritional and sensory qualities of sweet biscuits. *Journal of Nutrition, Health & Food Engineering*, 4(3), 430–435.
- Hugo, L. F., Rooney, L. W., & Taylor, J. R. N. (2000). Malted sorghum as a functional ingredient in composite bread. *Cereal Science*, 79(4), 428–432.
- Hussain, S., Anjum, F. M., Butt, M. S., Khan, M. I., & Asghar, A. (2006). Physical and

- sensorial attributes of flaxseed-flour-supplemented cookies. *Turkish Journal of Biology*, 30, 87–92.
- Jauharah, A. A., Rosliand, W. I., & Robert, S. D. (2014). Physicochemical and sensorial evaluation of biscuit and muffin incorporated with young corn powder. *Journal of Food Science and Technology*, 43(1), 45–52.
- Joel, N., Fatima, K., & Stephen, F. (2014). Production and quality assessment of enriched cookies from whole wheat and full-fat soya. *European Journal of Food Science and Technology*, 2(2), 19–29.
- Jyoti, & Jood, S. (2020). Physicochemical and nutritional composition of composite flour enriched with spinach leaves powder for development of value-added baked products. *International Journal of Chemical Studies*, 8(4), 1841–1844.
- KCJB, & Rai, B. K. (2007). *Basic Food Analysis Handbook* (pp. 76–82).
- Mamat, H., Abu Hardan, M. O., & Hill, S. E. (2010). Physicochemical properties of commercial semisweet biscuit. *Food Chemistry*, 121, 1029–1038.
- Murugkar, D. A. (2014). Effect of sprouting of soybean on the chemical composition and quality of soymilk and tofu. *Journal of Food Science and Technology*, 51(5), 915–921.
- Oomha, B. D. (1983). Baking and related properties of wheat–oat composite flour. *Cereal Chemistry*, 60(3), 220–225.
- Prabhavathi, C., Usha, M. S., & Bains, G. S. (1973). Effect of baking on protein quality of high-protein biscuits. *Indian Journal of Nutrition*, 91–95.
- Raidl, M. A., & Klein, B. P. (1983). Effects of soy or field pea flour substitution on physical and sensory characteristics of chemically leavened quick breads. *Cereal Chemistry*, 60, 367–370.
- Ranganna, S. (2012). *Handbook of analysis and quality control of fruits and vegetable products*. New Delhi, India: Tata McGraw Hill Publication Co.
- Sadasivam, S., & Manickam, A. (1992). *Biochemical methods for agricultural sciences* (pp. 12–13).
- Selvaraj, A., & Shurpalekar, S. R. (1982). On improving the quality of soy-fortified bread. *Journal of Food Science and Technology*, 19, 242–246.
- Sosulski, F. W., Humbert, E. S., Bui, K., & Jones, J. O. (1976). Functional properties of rapeseed-flour concentrates and isolates. *Journal of Food Science and Technology*, 41, 1348–1354.
- Wang, J., & Kinsella, J. E. (1976). Functional properties of novel protein: Alfalfa leaf protein. *Journal of Food Science and Technology*, 41, 286–292.
- Whitley, P. R. (1970). *Biscuit manufacture* (pp. 53–67). London, UK: Applied Science Publisher.
- Xiao, Z., Lester, G. E., Luo, Y., & Wang, Q. (2012). Assessment of vitamin and carotenoid concentrations of emerging food products: Edible microgreens. *Journal of Agricultural and Food Chemistry*, 60, 7644–7651.
- Yadav, R. B., Dhull, N., & Yadav, B. S. (2012). Effect of incorporation of plantain and chickpea flours on the quality characteristics of biscuits. *Journal of Food Science and Technology*, 49(2), 207–213.

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