

# Formulation and Sensory Evaluation of Ginger-Permeated Biscuits: A Study on Flavour, Texture, and Consumer Acceptability

Uswah Mansurah Zainudin<sup>1</sup> and Muhammad Muzaffar Ali Khan Khattak<sup>1,2\*</sup>

<sup>1</sup>Department of Nutrition Sciences, Kulliyah of Allied Health Sciences, International Islamic University Malaysia, Pahang, Malaysia

<sup>2</sup>Food Security and Public Health Nutrition Research Group (FOSTER), Kulliyah of Allied Health Sciences, International Islamic University Malaysia, Pahang, Malaysia

## ABSTRACT

### Keywords:

Ginger-Permeated, Biscuits, Spices, Sensory, Evaluation,

**Introduction:** The production of biscuits fortified with spices that offer health benefits is currently limited in variations. This study aims to formulate ginger biscuit recipes that achieve high acceptability. **Methods:** Three formulations of ginger-flavoured biscuits were created by incorporating additional ingredients such as chocolate chips and raisins, using buckwheat flour as the base. The sensory attributes and overall acceptability of the three formulations. Formulation 1 was based on only sugar, formulation 2 was enhanced with chocolate chips, and formulation 3 was enriched with raisins. A panel of thirty volunteers was randomly selected to evaluate the acceptability of the biscuits. The data were statistically analysed using One-way Analysis of variance (ANOVA). **Results:** The sensory characteristics revealed no significant differences among the formulations for their appearance, aroma, taste, crunchiness and overall acceptance. Overall, the data indicates that all biscuit formulations were acceptable to the panellists. **Conclusions:** All ginger-permeated biscuit formulations were equally acceptable to the panellists in quantity and other ingredients like sugar, chocolate chips or raisins.

\*Corresponding author.

E-mail address: muzaffar@iium.edu.my

## INTRODUCTION

Muffins, biscuits, cakes, and cookies are baked confectionery products consumed worldwide for sensory appeal. In both industrialised nations and emerging economies, these products contribute to obesity and type II diabetes due to their high sugar and fat content. Sugar and fat play multiple roles in baked confectionery products, influencing their structure, texture, shelf life, flavour, and aroma. Significant efforts have been made to modify product formulations to reduce sugar and fat content without compromising quality. Ginger, scientifically known as *Zingiber officinale*, is a dietary component widely used in food and beverages to enhance flavour. Beyond its culinary uses, ginger is well-known for its health benefits, aiding in the management of diabetes and hyperlipidaemia. In addition to its anti-diabetic, antioxidant, anti-obesity, and hypolipidemic properties, ginger possesses anti-inflammatory, neuroprotective, anti-glycating, and androgenic effects. Furthermore, ginger has been shown to influence carbohydrate metabolism, organ morphology, and metabolic profiles (Siregar et al., 2022). In Malaysia, the value of cookies and biscuits sold in 2022 was nearly 3.29 billion Malaysian ringgit. Compared to the previous year, the manufacturing sales value of cookies and biscuits has grown (Statista, 2023). This trend indicates

a rising demand for confectionery products, with consumers increasingly seeking out these types of food. Spices such as ginger in confectionery products like biscuits can enhance the functional food market while providing health benefits to consumers.

Therefore, this project aims to create a ginger-flavoured biscuit formulation that is acceptable and offers health benefits. It would provide a choice of confectionery product, specifically biscuits, that is highly acceptable across various sensory attributes.

## MATERIALS AND METHODS

### Development of Ginger Biscuits

The composition of the biscuits is presented in Table 1, with three different formulations produced. The ginger biscuit formulations consist of various ingredients. For each batch, the core ingredients include buckwheat flour, whole wheat flour, sugar, baking soda, ginger powder, vegetable oil, egg, and water. The first formulation contained no additional ingredients. In the second formulation, chocolate chips were added, while the third included raisins. All ingredients were thoroughly mixed to form a uniform dough, which was then shaped into circular portions. Each portion of dough was placed on baking

paper lined on a tray and baked for about fifteen minutes in a preheated oven at 180°C. Once baked, the biscuits were cooled to room temperature and stored in an airtight container.

Table 1: The composition of ginger biscuits of three formulations.

	Formulation		
	F1	F2	F3
Buckwheat Flour (g)	70	70	70
Whole Wheat flour (g)	30	30	30
Sugar (g)	50	50	50
Baking Soda (g)	1.25	1.25	1.25
Ginger Powder (g)	7.5	7.5	7.5
Vegetable oil (g)	25	25	25
Egg (g)	20	20	20
Water (g)	7	7	7
Chocolate Chip (g)	-	20	-
Raisins (g)	-	-	20

### Panellists

Thirty panellists consisting of students from the International Islamic University Malaysia, were recruited for this study. Students with health issues or who had lost the ability to sense smell or taste were excluded from participating in this study.

### Sensory Evaluation

The sensory evaluation was carried out in the sensory evaluation laboratory, Department of Nutrition Sciences, Kulliyah of Allied Health Sciences. The intended sensory parameters, score options, and numerical rankings were listed on the evaluation forms of the panellists. The biscuits were rated using a 9-point hedonic scale and tested on several acceptability parameters, including appearance, aroma, taste, and texture. The appearance of the ginger biscuits was evaluated for their colour and shape, while their aroma was assessed for its fragrance. For the taste, the ginger biscuits were judged on sweetness, and the texture was evaluated in terms of crunchiness and chewiness. The hedonic scale ranged from 'extremely like' to 'extremely dislike,' with scores ranging from 1-9. To measure the level of liking and overall pleasantness or unpleasantness of the consumption experience of the biscuits. The evaluation was conducted over five sessions, each consisting of six panellists. Each panellist was served three biscuit samples from different formulations, with an evaluation form, each corresponding to one biscuit sample. Panellists were provided with a glass

of plain water to cleanse their palate between tastings. All panellists were instructed to refrain from discussing or communicating with each other during the session. Each session lasted approximately 10 - 15 minutes, with a 5-minute gap between sessions for room evacuation and preparation for the next group.

### STATISTICAL ANALYSIS

The collected data were entered into the Statistical Package for the Social Sciences (SPSS Version 12.01) and sorted for analysis. The mean scores for each sensory attribute i.e. appearance (colour and shape), aroma, taste (sweetness), texture (crunchiness and chewiness), and overall acceptance were compared among the three different formulations using One-way analysis Variance (ANOVA). The significance level was set at  $p < 0.05$  at 95% CI. A post hoc test was conducted using the Tukey HSD test to determine the significant differences between the three formulations' sensory characteristics.

### RESULTS

The results of this study are presented in Table 2. The sensory attributes evaluated included appearance (colour and shape), aroma, taste (sweetness), texture (chewiness and crunchiness), and overall acceptability. The statistical analysis revealed no significant differences across the three ginger biscuit formulations in these sensory parameters. This indicates that the panellists found all formulations equally acceptable, regardless of the differences in ingredients between the samples. Formulation 1 was a basic ginger biscuit, formulation 2 contained chocolate chips, and formulation 3 included raisins. Despite these ingredient variations, the overall sensory experience for the panellists remained consistent. Although formulation 2, which contained chocolate chips, tended to score slightly higher in some areas, such as appearance, aroma, sweetness, and crunchiness, these differences were not statistically significant. This suggests that chocolate chips may have offered a slight edge in preference for some attributes, but not enough to distinguish it markedly from the other formulations regarding overall acceptability. The lack of significant differences in sensory attributes indicates that the variations in ingredients did not lead to strong preferences among the panellists, and all formulations were similarly well-received. The consistent level of acceptance across the different formulations highlights the versatility of the base recipe, which performed well regardless of the additional ingredients. Overall, the results suggest that each ginger biscuit formulation was equally appealing to the panellists, making any of them a viable option for further development.

Table 2 The Mean score of the Sensory Characteristics between Formulations

Sensory Characteristics	N	F1	F2	F3	Significance Level
		Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	
Colour	30	7.47 $\pm$ 1.33	7.60 $\pm$ 1.19	7.40 $\pm$ 1.45	p= 0.839 NS
Shape	30	7.83 $\pm$ 1.26	7.93 $\pm$ 1.02	7.57 $\pm$ 1.48	p= 0.513
Aroma	30	6.97 $\pm$ 1.27	7.40 $\pm$ 1.35	6.80 $\pm$ 1.27	p= 0.188
Sweetness	30	6.73 $\pm$ 1.31	7.27 $\pm$ 1.20	6.87 $\pm$ 1.46	p= 0.274
Crunchiness	30	5.10 $\pm$ 1.40	5.90 $\pm$ 1.32	5.83 $\pm$ 1.29	p= 0.041
Chewiness	30	6.23 $\pm$ 1.50	6.53 $\pm$ 1.55	6.30 $\pm$ 1.64	p= 0.739
Overall Acceptance	30	6.63 $\pm$ 1.22	7.17 $\pm$ 1.32	6.67 $\pm$ 1.37	p= 0.213

## DISCUSSION

Sensory evaluation in foods is defined as a tool or a technique used to measure human responses to food, ultimately influencing consumer perceptions (Golden et al. (2010). Sensory characteristics such as appearance, aroma, colour, texture, and taste are key factors affecting food quality and consumer preferences. The sensory evaluation was conducted in a controlled laboratory environment, ensuring factors like lighting, ventilation, noise, and extraneous odours did not interfere with the results. Panellists were instructed to avoid discussing or communicating with one another to decrease distractions and bias. Additionally, they were required to cleanse their palates between samples to enhance the accuracy of the evaluation and maintain responsiveness to new stimuli (Kemp, 2008).

The colour of ginger biscuits is a critical quality factor in consumer acceptance (Sharif et al., 2017). Yang et al. (2019) found that while ginger-free biscuits appeared plain, those with 1% ground ginger had a more golden yellow shade. In this study, the final ginger biscuits had a golden-brown colour, likely due to the higher proportion of buckwheat flour, which is more fibrous and darker than wheat flour. Baking at 180°C also contributed to this golden-brown colour through the Maillard reaction, which occurs at temperatures above 160°C (Mesías et al., 2016). The panellists found the appearance of all biscuit formulations to be acceptable. Similarly, aroma plays an important role in the perceived quality of ginger biscuits, often influencing whether a product is accepted or rejected before tasting. Sharif et al. (2017) noted that a pleasant aroma enhances taste. Filipčev et al., (2012) found that the ginger aroma masked the buckwheat scent

in composite biscuits, without significantly altering taste. We recorded, no differences in the aroma acceptability between the three formulations. However, Formulation 2, which contained chocolate chips, scored the highest for aroma on the hedonic scale.

Furthermore, the taste acceptability also increased with adding ginger and chocolate chips. The slight bitterness of the chocolate is probably balanced by the sweetness of the biscuits, contributing to higher acceptability. While all three formulations were generally accepted, Formulation 2 had the highest overall preference since statistically no differences were recorded for the taste in the formulations under investigation (Hayek, & Ibrahim, 2013)..

Texture is another critical factor in biscuit acceptability and consumers generally prefer a balance between crunchiness and chewiness. Buckwheat flour contributes to the hardness and tractability of biscuits, increasing flour added (Filipčev et al., 2012). However, the addition of fat, such as oil, acts as a lubricant and improving dough malleability and moulding properties (O'Sullivan, 2017). The ginger biscuits in this study were chewier than crunchy, with chewiness scoring an average of 6.35, compared to 5.61 for crunchiness. Both textures were deemed acceptable, with scores indicating "slight liking" and "neutral" responses, respectively.

For any confectionary product, overall acceptability is a critical measure of consumer perceptions, encompassing all sensory attributes. There were no statistical differences, however, formulation 2 was preferred across all sensory parameters, with an overall acceptance score of 7.17. This suggests that adding chocolate chips or raisins enhances consumer acceptance, as formulations without these ingredients received lower scores, possibly due to the stronger buckwheat flavour overpowering the ginger.

## CONCLUSIONS

This study aimed to propose a new variation of confectionary products such as biscuits with some health benefits and to compare the acceptability of the three formulations. Thus, it can be concluded that this study can produce good ginger biscuit recipes that have good appearance (colour and shape) aroma, taste (sweetness), texture (crunchiness and chewiness), and overall acceptance. These findings showed that ginger biscuits were generally well-received, demonstrating that this product may be regarded as being well-received by panellists. As a result, the findings of this study can be used to produce different confectionary goods with certain health advantages.

## ACKNOWLEDGMENTS

The authors would like to sincerely express thankfulness towards the panellists for their cooperation and participation in this study. We would also like to thankfully acknowledge the facilities provided by the Department of Nutrition Sciences, Kulliyah of Allied Health Science, International Islamic University Malaysia

## REFERENCES

- Chopra, N., Dhillon, B., Rani, R., & Singh, A. (2018). Physico-nutritional and sensory properties of cookies formulated with quinoa, sweet potato and wheat flour blends. *Current Research in Nutrition and Food Science*, 6(3), 798–806. <https://doi.org/10.12944/CRNFSJ.6.3.22>
- Filipčev, B., Bodroža-Solarov, M., Filippev, B., Olivera, •, & Marija Bodroža-Solarov, Š. •. (2012). Enrichment of Ginger Nut Biscuits with Wholegrain Buckwheat and Rye Flour. *The European Journal of Plant Science and Biotechnology*. <https://www.researchgate.net/publication/284169396>
- Garvey, E. C., O’Sullivan, M. G., Kerry, J. P., & Kilcawley, K. N. (2020). Factors influencing the sensory perception of reformulated baked confectionary products. In *Critical Reviews in Food Science and Nutrition* (Vol. 60, Issue 7, pp. 1160–1188). Taylor and Francis Inc. <https://doi.org/10.1080/10408398.2018.1562419>
- Golden, D. A., Hartel, R. W., Heymann, H., Hotchkiss, J. H., Johnson, M. G., Montecalvo, J., Nielsen, S. S., & Silva, J. L. (2010). *Sensory Evaluation of Food*. <https://doi.org/10.1007/978-1-4419-6488-5>
- Here is the completed reference:
- Hayek, S. A., & Ibrahim, S. A. (2013). Evaluation of chocolate chip cookie formulations with fat and sugar substitutes. *Emirates Journal of Food and Agriculture*, 25\*(3), 159-168.
- Jessica Elizabeth, D. L. T., Gassara, F., Kouassi, A. P., Brar, S. K., & Belkacemi, K. (2017). Spice use in food: Properties and benefits. *Critical Reviews in Food Science and Nutrition*, 57(6), 1078–1088. <https://doi.org/10.1080/10408398.2013.858235>
- Jiang, T. A. (2019). Health benefits of culinary herbs and spices. In *Journal of AOAC International* (Vol. 102, Issue 2, pp. 395–411). AOAC International. <https://doi.org/10.5740/jaoacint.18-0418>
- Kausar, T. (2017). Effect of ginger powder incorporation on physicochemical and organoleptic characteristics of biscuits. *Pure and Applied Biology*, 6(4). <https://doi.org/10.19045/bspab.2017.600132>
- Kemp, S. E. (2008). Application of sensory evaluation in food research: Editorial. In *International Journal of Food Science and Technology* (Vol. 43, Issue 9, pp. 1507–1511). <https://doi.org/10.1111/j.1365-2621.2008.01780.x>
- Kiyama, R. (2020). Nutritional implications of ginger: chemistry, biological activities and signaling pathways. In *Journal of Nutritional Biochemistry* (Vol. 86). Elsevier Inc. <https://doi.org/10.1016/j.jnutbio.2020.108486>
- Manley, D., & Clark, H. (2011). Biscuit baking. In *Manley’s Technology of Biscuits, Crackers and Cookies: Fourth Edition* (pp. 477–500). Elsevier Ltd. <https://doi.org/10.1533/9780857093646.4.477>
- Mesías, M., Holgado, F., Márquez-Ruiz, G., & Morales, F. J. (2016). Risk/benefit considerations of a new formulation of wheat-based biscuit supplemented with different amounts of chia flour. *LWT*, 73, 528–535. <https://doi.org/10.1016/j.lwt.2016.06.056>
- O’Sullivan, M. G. (2017). Sensory Properties of Bakery and Confectionary Products. In *A Handbook for Sensory and Consumer-Driven New Product Development* (pp. 305–324). Elsevier. <https://doi.org/10.1016/b978-0-08-100352-7.00014-2>
- Pirmamat, F., & Ph, N. (2022). The Value of Confectionary Products in Human Nutrition. *Web of Scientist: International Scientific Research Journal*, 3(4), 2776–0979.
- Ramadas, A., Tham, S. M., Lalani, S. A., & Shyam, S. (2021). Diet quality of Malaysians across lifespan: A scoping review of evidence in a multi-ethnic population. In *Nutrients* (Vol. 13, Issue 4). MDPI AG. <https://doi.org/10.3390/nu13041380>

Schouten, M. A., Tappi, S., Glicerina, V., Rocculi, P., Angeloni, S., Cortese, M., Caprioli, G., Vittori, S., & Romani, S. (2022). Formation of acrylamide in biscuits during baking under different heat transfer conditions. *LWT*, 153. <https://doi.org/10.1016/j.lwt.2021.112541>

Serafini, M., & Peluso, I. (2016). Functional Foods for Health: The Interrelated Antioxidant and Anti-Inflammatory Role of Fruits, Vegetables, Herbs, Spices and Cocoa in Humans. *Current Pharmaceutical Design Journal*.

Sharif, M. K., Rizwan Sharif, H., & Nasir, M. (2017). *Sensory Evaluation and Consumer Acceptability Characterization and utilization of spirulina for food applications* View project. <https://www.researchgate.net/publication/320466080>

Singh, A., & Kumar, P. (2018). Gluten free approach in fat and sugar amended biscuits: A healthy concern for obese and diabetic individuals. *Journal of Food Processing and Preservation*, 42(3). <https://doi.org/10.1111/jfpp.13546>

Siregar, R. S., Hadiguna, R. A., Kamil, I., Nazir, N., & Nofialdi, N. (2022). Ginger (*Zingiber officinale* R.) as a Potent Medicinal Plant for the Prevention and Treatment of Diabetes Mellitus: A Review. In *Tropical Journal of Natural Product Research* (Vol. 6, Issue 4, pp. 462–469). Faculty of Pharmacy, University of Benin. <https://doi.org/10.26538/tjnpr/v6i4.2>

Srinivasan, K. (2017). Ginger rhizomes (*Zingiber officinale*): A spice with multiple health beneficial potentials. In *PharmaNutrition* (Vol. 5, Issue 1, pp. 18–28). Elsevier B.V. <https://doi.org/10.1016/j.phanu.2017.01.001>

Statista Research Department, & 1, M. (2023, March 1). *Malaysia: Sales value of manufactured biscuits and cookies 2022*. Statista. <https://www.statista.com/statistics/642400/sales-value-of-manufactured-biscuits-and-cookies-in-malaysia/>

Talaei, B., Msc, ;, Mozaffari-Khosravi, H., Phd, ;, & Bahreini, S. (2017). The Effect of Ginger on Blood Lipid and Lipoproteins in Patients with Type 2 Diabetes: A Double-Blind Randomized Clinical Controlled Trial. In *Journal of Nutrition and Food*

Yang, H., Li, L., Yin, Y., Li, B., Zhang, X., Jiao, W., & Liang, Y. (2019). Effect of ground ginger on dough and biscuit characteristics and acrylamide content. *Food Science and Biotechnology*, 28(5), 1359–1366. <https://doi.org/10.1007/s10068-019-00592-x>

Zhang, M., Zhao, R., Wang, D., Wang, L., Zhang, Q., Wei, S., Lu, F., Peng, W., & Wu, C. (2021). Ginger (*Zingiber officinale* Rosc.) and its bioactive components are potential resources for health beneficial agents. In *Phytotherapy Research* (Vol. 35, Issue 2, pp. 711–742). John Wiley and Sons Ltd. <https://doi.org/10.1002/ptr.6858>