Original Research Article

Enhancing Cake Nutrition with *Lepidiota mansueta* Flour

ABSTRACT

The incorporation of white grub (*Lepidiota mansueta*) flour into cakes was explored to assess its impact on both nutritional composition and sensory attributes. Cakes were prepared with varying ratios of white grub flour to whole wheat flour, ranging from 10% to 30% substitution. Results indicated a progressive increase in moisture, crude protein, crude fat, crude fiber, ash, and energy content with higher concentrations of white grub flour, while carbohydrate content exhibited a decreasing trend. Mineral analysis revealed elevated levels of sodium, potassium, manganese, zinc, and copper with increased white grub flour incorporation. Sensory evaluation demonstrated that cakes with pure wheat flour and those with 10% white grub flour substitution garnered the highest overall acceptability scores, whereas acceptability declined with higher white grub flour concentrations. These findings underscore the potential of white grub flour as a nutritious ingredient, albeit with varying degrees of acceptance in baked products.

Keywords: Anthroentomophagy, Malnutrition, Lepidiota mansueta, cakes, food

1. INTRODUCTION

As the global population increases, the challenges of ensuring food security has become one of the paramount concerns of humanity. Limited freshwater resources and cultivable land poses a significant barriers to meeting the nutritional needs of an expanding global population [1]. Approximately 2 billion peoples of worldwide are facing some degree of food insecurity. Further, the food industry and agriculture emerge as significant contributors to environmental degradation. Studies indicate that the food industry is accountable for 26–50% of greenhouse gas emissions, while agriculture is responsible for about 80% of the anthropological water footprint [2]. Apart from these, protein production, particularly from livestock breeding causes major environmental impact by emitting substantial greenhouse gases. To tackle malnutrition and environmental concerns simultaneously, an innovative solution lies in the practice of *Anthroentomophagyi.e.,* the consumption of terrestrial and aquatic insects by humans. Additionally, insects are a more ecologically friendly alternative than traditional livestock since they require less water and feed. The Entomophagy has ancient roots and is prevalent across various species, notably among our primate predecessors [3]. Based on the insectivory seen in the chimpanzees, it has been suggested that edible insects may have played a key role in human evolution [4].The nutritional composition of insects aligns with human dietary needs, containing high-quality protein, diverse carbohydrates, and micronutrients such as vitamin B, E, iron, magnesium & zinc, and might be effectively used malnutrition management [5]. Furthermore, insects demonstrate impressive food conversion efficiency, in comparison with mammalian livestock [6]. Their efficiency of conversion of ingested food (ECI) surpasses that of traditional meats, making them an attractive prospect for sustainable food production [7].

An indigenous species of white grub, *L. mansueta*, belonging to the Scarabaeidae family in the order Coleoptera, has been found to be a major pest in a variety of agricultural crops such as potato, sugarcane, colocasia, green gram etc in Majuli, Assam [8].Interestingly, despite being a pest, the adults of *L. mansueta* are highly valued delicacies among the local tribal people of Majuli, especially the Mising tribe. The beetles are traditionally prepared by removing their hard elytra and legs before frying or roasting them. Recognizing the growing interest among the local tribal communities, a study on the nutritional profile of *L. mansueta* beetle powder revealed a considerable amount of crude protein, along with other proximate parameters such as crude fat, crude fiber, total minerals, carbohydrates, and energy [9]. However, the culinary acceptance of *L. mansueta* faces challenges, particularly in terms of storage and consumer reluctance to consume whole cooked beetles [24]. In response to these challenges, the current study aims to explore innovative culinary avenues by developing a recipe for cake based on *L. mansueta* powder. The objective aiming to create value-added food products that could find a place on the global stage by transforming *L. mansueta* into a convenient and palatable form.

2. MATERIAL AND METHODS

The research was conducted in 2020–2021 at the Assam Agricultural University, Jorhat, in the laboratories of the department of entomology and department of biochemistry and agricultural chemistry.

2.1 Preparation of *L. mansueta* flour

Adult *L. mansueta* beetles from Majuli, Assam, were captured in April using water traps. For euthanization process beetles were immersed in lukewarm water for 15 minutes.Afterward, wings and legs were removed, and the edible parts were dried and processed into uniform beetle flour with a mechanical grinder. To ensure consistency, the flour was sifted through fine strainers. The powdered beetles were stored in airtight containers in refrigerated conditions

2.2 Preparation of cakes

Cakes were prepared by using methodology described by Lin *et al*. (2017) with minute modification, where *L. mansueta* powder and wheat flour (WF) were mixed in various proportions *viz.,* 0:100, 10:90, 20:80, and 30:70 [10]. The basic elements *i.e.,* wheat flour, milk, butter, sugar, and baking powder were thoroughly mixed, further water was added until the desired consistency was achieved, and the batter was baked at 180 °C for 30 minutes. After baking, the cakes were sealed in airtight containers and refrigerated for subsequent biochemical evaluation.

2.3 Proximate and elemental Composition Determination

The proximate composition of the cakes such as moisture, crude protein, crude ash, crude fat, and crude fiber contents were assessed by following the methodologies recommended by AOAC (2000) [11]. While,carbohydrate and energy contents were determined through methodologies by Hedge and Hofreiter (1962) and F A O (2003) methods respectively [12, 13]. Additionally, Elemental composition, including Mn, Zn, Cu, Na, and K, was assessed using a flame atomic absorption spectrophotometer and methodologies outlined by John and Van (1980) and AOAC (1970) [14, 15].

2.4 Sensory Evaluation

Ten trained individuals assessed for taste, appearance, crispiness, aroma, texture, and overall acceptability for cakes on a 9-point scale [16]. The parameter includes: dislike very much (0-2), dislike moderately (2.1-3), dislike slightly (3.1-4), neither like nor dislike (4.1-5), like slightly (5.1-6), like moderately (6.1-7), like very much (7.1-9).

2.5 Statistical analysis

Biochemical parameters and organoleptic quality were analyzed using Completely Randomized Design (CRD). Significance of variance was assessed at a 5% probability level with 'F' value, following Panse and Sukhatme's (1985) method [17].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of the Cakes Samples

The findings presented in Table 1.0 provide a comprehensive insight into the proximate composition analysis of *L. mansueta* fortified cakes. The progressive increase in the proportion of *L. mansueta* flour, ranging from 10% to 30%, exhibited a consistent rise in moisture content, reaching values between 23.07% and 25.52%. These levels were notably higher than those found in cakes made solely with wheat flour, which recorded a moisture content of 19.92%. The elevation in moisture content attributed to the hydrophilic nature of *L. mansueta* beetle flour. Elevation of moisture, however, had no influence on shelf stability because it stayed within acceptable ranges as evidenced by Erkmen and Bozoglu's (2016) findings [18]. Concurrently, an incremental trend was noted in the percentage of crude protein (13.30% to 26.43%), crude fat (20.10% to 23.06%), crude fibre (0.66% to 0.84%), and ash content (1.31% to 1.96%) with increasing *L. mansueta* flour concentration from 10 to 30 per cent. Further, Cakes supplemented with *L. mansueta* showed noticeably better nutritious contents than cakes made only with wheat flour. Significant levels of crude protein (76.42%), crude fat (4.10%), crude fibre (5.16%), and total minerals (2.90%) were found in *L. mansueta* beetle flour in previous research conducted by Bhattacharyya and his co-worker in the year of 2018 [9]. The addition of *L. mansueta* flour to wheat flour during the manufacturing of value-added products led to higher levels of crude protein, crude fat, crude fibre, and ash content than those seen in biscuits that did not include *L. mansueta* flour. These results are consistent with the findings of Ayensu *et al*. (2019) and Adeboye *et al.* (2016)[19,20]. Furthermore, a notable transformation in the carbohydrate content was observed, declining gradually from 61.62% to 44.43% as the percentage of *L. mansueta* flour increased from 10% to 30%. This reduction can be linked to the inherently lower carbohydrate content (9.18%) reported in *L. mansueta* flour by Bhattacharyya *et al*. (2018) [9]. The incorporation of *L. mansueta* flour not only led to a decrease in sugar intake but also offered the added benefit of higher fiber content. These finding aligns with the findings of Ayensu *et al*. (2019) [19]. Additionally, the energy content analysis revealed a gradual increase in energy content as the proportion of *L. mansueta*powder rose from 10% to 30%, ranging from 481.94 to 492.67 Kcal. In contrast, cakes made exclusively from 100% wheat flour displayed the lowest energy content at 509.27 kcal/100g. This rise in energy content is attributed to the significant fat content present in *L. mansueta* flour. Further results were consistent with observations from Zielinska and Pankiewicz (2020) and Ogunlakin *et al*. (2018) [21,22].

Table 1.0 Proximate composition of cake prepared from *L. mansueta* beetle flour

Treatment	Moisture	Crude Protein	Crude Fat	Crude Fibre	Carbohydrate	Ash	Energy
				(%)			(kcal/100g)
T_1 (10:90)	23.07±0.13	13.30±0.65	20.10±0.60	0.66±0.05	61.62±1.27	1.31±0.20	481.94±8.76
T_2 (20:80)	24.40±0.54	19.34±0.54	21.31±0.33	0.75±0.04	53.13±2.72	1.65±0.09	483.23±9.75
T_3 (30:70)	25.52±0.45	26.43±1.22	23.06±0.48	0.84±0.04	44.43±2.56	1.96±0.278	492.67±15.81
T_4 (0:100)	19.92±0.64	7.00±0.45	17.46±0.55	0.54±0.04	73.02±1.27	0.80±0.10	478.35±9.06
S. Ed (±)	**0.39**	**0.55**	**0.35**	**0.029**	**1.47**	**0.13**	**7.93**
CD (p=0.05)	**0.83**	**1.17**	**0.75**	**0.061**	**3.13**	**0.28**	**16.91**

3.2 Elemental Compositionof cakes prepared from *L. mansueta* beetle flour

Table 2.0 presents a comprehensive overview of the elemental composition of *L. mansueta*-enriched cakes, showcasing a remarkable rise in elemental content (mg/100g). The incremental incorporation of *L. mansueta* flour, ranging from 10 to 30 percent in the cakes, led to a consistent increase in Na (43.183-46.375), K (41.721-46.676), Mn (0.882-3.361), Zn (0.701-3.041), and Cu (0.094-0.394). This substantial augmentation underscores the efficacy of integrating *L. mansueta* flour as a valuable source of essential minerals in value-added food products compared to 100 percent wheat flour cakes. The observed variations in elemental composition offer crucial insights into the potential nutritional benefits associated with *L. mansueta* flour inclusion. Notably, these findings align with Akullo and his co-worker in 2018, who reported increased Fe and Zn in crackers substituting wheat flour with cricket and termite flour, and Ayensu *et al*. (2019), who noted elevated Ca, Fe, and Zn in biscuits blending palm weevil larvae flour with wheat flour [16,19].

Table 2.0 Elemental composition of cake prepared from *L. mansueta* beetle flour

Treatment	Sodium (Na)	Potassium (K)	Manganese (Mn)	Zinc (Zn)	Copper (Cu)
			mg/100g		
T_1 (10:90)	43.183±0.764	41.721±0.249	0.882±0.022	0.701±0.069	0.094±0.029
T_2 (20:80)	45.976±0.108	43.118±0.273	2.293±0.091	1.164±0.073	0.145±0.014
T_3 (30:70)	46.375±0.655	46.676±0.255	3.361±0.029	3.041±0.065	0.394±0.024
T_4 (0:100)	38.795±0.868	40.439±0.509	0.364±0.009	0.263±0.017	0.056±0.009

S. Ed (±)	**0.472**	**0.240**	**0.031**	**0.041**	**0.013**
CD (p=0.05)	**1.004**	**0.511**	**0.063**	**0.083**	**0.034**

3.3 Organoleptic quality evaluation of cakes prepared from *L. mansueta* beetle flour

The organoleptic evaluation of cakes made with flour from the *L. mansueta* beetle is detailed in Table 3.0, revealing the impact of substitution on sensory attributes. Cakes prepared solely with wheat flour secured the highest ratings across appearance (7.70), color (7.50), flavor (7.70), taste (7.50), and overall acceptability (7.80). Notably, a 10% substitution of *L. mansueta* flour fortified cakes exhibited statistically parity ($P \leq 0.05$) for appearance (7.40), color (7.30), flavor (7.30), taste (7.20), and overall acceptability (7.50). However, cakes with 20% and 30% substitution of *L. mansueta* flour did not maintain statistical parity with the control group, indicating a decline in organoleptic satisfaction at higher substitution levels. These results align with earlier studies by Simeon *et al*. (2018) and Ogunlakin *et al*. (2018)[23,22].

Table 3.0 Organoleptic quality evaluation of the cake prepared from *L. mansueta* beetle flour

Treatment	**Appearance**	**Colour**	**Flavour**	**Taste**	**Overall acceptability**
T_1 (10:90)	7.40±0.50	7.30±0.87	7.30±1.12	7.20±0.67	7.50±0.53
T_2 (20:80)	6.80±0.88	6.70±1.00	6.60±1.13	6.80±0.44	6.90±0.86
T_3 (30:70)	6.60±0.50	6.60±0.44	6.50±1.01	6.70±0.71	6.80±0.70
T_4 (0:100)	7.77±0.88	7.50±0.53	7.70±1.13	7.50±0.53	7.80±0.44
S. Ed (±)	**0.39**	**0.36**	**0.52**	**0.26**	**0.29**
CD (p=0.05)	**0.79**	**0.72**	**1.05**	**0.52**	**0.62**

4. CONCLUSION

In our effort to prepare cakes enriched with *L. mansueta* flour and assess its nutritional quality, we have observed a higher content of proximate components as well as elemental components compared to the cakes prepared solely with wheat flour. However, the sensory analysis results unveiled a decrease in the overall acceptance of the cakes as the proportion of *L. mansueta* flour increased. Based on these findings, we can conclude that *L. mansueta* flour can be effectively utilized as a supplement to wheat flour, with an optimal ratio of 10:90, in the development of protein-rich value-added food products.

REFERENCES

1. Fan S, Brzeska J. Sustainable food security and nutrition: Demystifying conventional beliefs. Glob. Food Secur. 2016; 11 (2): 11–16.
2. Poore J, Nemecek T. Reducing food's environmental impacts through producers and consumers. Science. 2018; 360 : 987–992
3. Van Huis A. Insects as food in sub-Saharan Africa. Insect Science and Its Application. 2003;23(3): 163-85.
4. McGrew W C, Linda F, Marchant C, Payne C, Webster T, Hunt K D. Chimpanzees at Semliki in oil palms. Folia Primatologica.2010; **28**: 109-121.
5. Biro B, Sipos M A, Kovacs A, Badak-Kerti K, Pasztor-Huszar K, Gere A. Cricket enriched oat biscuit: technological analysis and sensory evaluation. Foods. 2020; 9(4): 159-164.
6. FAO. Edible insects: Future prospects for food and feed security. FAO Foresty Paper.2013;171: 1-154.
7. Chakravorty J. Entomophagy an ethnic cultural attribute can be exploited to control increased insect population due to global climate change: a case study. Proceedings. International Human Dimensions Programme, Seventh International Science Conference on Human Dimensions of Global Environmental Change, Bonn, Germany. 2009; pp. 26-30.
8. Bhattacharyya B, Dutta S K. White grubs as emerging pests in the North Eastern region of India and their management. Proceedings of National Symposium on Entomology as a Science and IPM as a Technology-the Way Forward. 2014; p. 14-15. CAU, Pasighat, Arunachal Pradesh.
9. Bhattacharyya B, Choudhury B, Bhagawati S, Dutta K S, Pathak K, Das, P. Nutritional composition of five soil-dwelling scarab beetles (Coleoptera: Scarabaeidae) of Assam, India. ColeopteristsBulletin. 2018;72(2): 339-46.
10. Lin M, Tay S H, Yang H, Yang B, Li H. Development of eggless cakes suitable for lacto vegetarians using isolated pea proteins. Food Hydrocolloids. 2017; 69: 440-449.
11. AOAC. Official Method of Analysis. Report of the Association of Official Analytical Chemists. 17^{th} ed.Washington, D.C., USA. 2000.
12. Hedge J E, Hofreiter B T. Carbohydrate chemistry, Academic Press, New York.1962.
13. FAO. FAO, Food energy-method of analysis and conversion factors, Food and nutrition paper, Food and Agriculture Organization of the United States.2003; 77: 1-93.
14. John C, Van L. Analytical Atomic Absorption Spectroscopy, Academic Press, Inc. Orlando, Florida. 1980.
15. AOAC. Official Methods of Analysis. Report of the Association of Official Analytical Chemists. Washington, DC. 1970.
16. Akullo J, Nakimbuguse D, Oboa B B, Okwee-Acai J, Agea J G. Development and quality evalution of crackers enriched with edible insects. International Food Research Journal. 2018;25(4): 1592-1599.
17. Panse V S, Sukhatme P V. Statistical methods for agricultural workers, ICAR, New Delhi.1985.
18. Erkmen O, Bozoglu T F. FoodPreservation by Reducing Water Activity. In. Food Microbiology: Principles into Practice 1^{st} ed., John Wiley & Sons, Ltd. 2016.
19. Ayensu J, Lutterod H, Annan R A, Edusei A,Loh S P. Nutritional composition and acceptability of biscuits fortified with palm weevil larvae (*Rhynchophorus phoenicis Fabricius)* and orange-fleshed sweet potato among pregnant women. Food Science and Nutrition. 2019; 7:1807-1815.

20. Adeboye A O, Bolaji T A, Fatola O L. Nutritional composition and sensory evaluation of cookies made from wheat and palm weevil larvae flour blends. Annals. Food Science and Technology. 2016; 17(2): 541-552.
21. Zielinska E, Pankiewicz U. Nutritional, physiochemical, and antioxidative characteristics of shortcake biscuits enriched with *Tenebrio molitor* flour. Molecules.2020; 26(5629): 546-551.
22. Ogunlakin G O, Oni V T, Olaniyan, S A. Quality evaluation of biscuit fortified with edible termite (*Macrotermes nigeriensis*). Asian Journal of Biotechnology and Bioresource Technology.2018;4(2): 1-7.
23. Simeon E, John O O, Awodi U P, Aminat Y. Production and evaluation of the physico-chemical and sensory properties of biscuit from wheat and cricket flours. Acta Scientific Nutritional Health.2018; 2(1): 256-258.
24. Bhattacharyya B, Gogoi I, Das PP, Kalita B. Management of agricultural insect pests for sustainable agriculture and environment. InSustainable Agriculture and the Environment 2023 Jan 1 (pp. 161-193). Academic Press.