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Consumer Acceptance and Sensory Properties of Wheat-Millet Composite Biscuits Fortified with *Moringa oleifera* and *Camellia Sinensis* Leaves Powder

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Abstract

This study investigated the consumer acceptability of biscuits prepared with millet-wheat composite flour and enriched with *Moringa oleifera* and green tea leaves in Karachi, Pakistan. Cereals, especially wheat, and millet are crucial in global food trade. *Moringa oleifera* and green tea, rich in essential nutrients and phytochemicals, are of growing interest for their potential health benefits when added to food products. Sensory analysis and preference survey were conducted to evaluate the acceptance of these fortified unconventional biscuits. The results showed that biscuits made with pearl millet, moringa, and green tea were generally well-received by the panelists ($p \leq 0.05$). However, biscuits with green tea had slightly lower acceptability, likely due to their higher moisture content impacting texture and taste. Consumer perception survey revealed a notable interest in moringa-fortified biscuits among health-conscious consumers. While some consumers expressed a willingness to try biscuits made with pearl millet flour, there is an opportunity to raise awareness about the benefits of this grain. These findings underscore the potential for fortified biscuits, rich in essential nutrients, to provide healthier alternatives and address food insecurity, particularly among undernourished populations. The study highlights the importance of creating value added products by underutilized grain with acceptable organoleptic profiles to facilitate their adoption in the market.

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Introduction

According to World Food and Agriculture – Statistical Yearbook cereals are most traded food commodities by quantity in the year 2020. The Americas and Europe are the largest exporters of cereals, while the Asia is the largest importer.[1] Pakistan imported 2490628 and 2486191 tons of wheat for the year 2020 and 2021, respectively.[2] Other than a variety of staple flatbreads (roti, naan, and sheermal, etc.), wheat is widely used to prepare biscuits, cakes, noodles, and breads in Pakistan. Biscuits are convenience food which attracted a wide consumption base due to its lower processing expenditure, easier-to-carry and convenient-to-eat, and longer shelf stability attributes.[3] There is a great interest in the food industry to improve the biscuits properties [4-6] and to fortify these bakery products with underutilized parts or with by-products of the food industry.[7,8]

Millet is a tall, warm-season annual grass of the Poaceae family. It is a locally known as Bajra in Pakistan, and is a summer crop grown for both human food and animal feed.[9] The top three producers of millets are India, China and Niger whereas, Pakistan stands at the 16th rank with the total production of 226317 tonnes.[2]

Tea is one of the oldest cash crop. The leaves of small shrub, *Camellia sinensis* are used to make tea. Black tea and green tea are the completely fermented and non-fermented forms of tea leaves, respectively.[10] Tea plants were originated from south-west of China around 5000 years ago. Now, it is cultivated in more than 58 countries with an estimated production area of 4.37 million ha.[11]

The production of tea is increasing at a much quicker pace than that of many other crops, including coffee and staple food grains like rice and wheat.[12] The top producers of green tea are China, Japan and Vietnam. World green tea production is projected to increase at a rapid rate of 6.3% annually, reflecting development in China, where output is anticipated to nearly twofold by 2030.[13] The supplementation of green tea extracts and powders has been studied in various food products such as biscuits [14,15] and different types of sauces like coriander sauce[16] and soy sauce.[17]

Moringa oleifera, a moderate size tree, is native to the western and sub-Himalayan regions, as well as Pakistan, India, Asia Minor, Africa, and Arabia. Its cultivation has extended to Central America, Cambodia, the Philippines, the Caribbean Islands, and North and South America. It is commonly known as the Suhajna tree in Pakistan, but has many other regional names, including horseradish tree, drumstick tree, marango tree, saijihan tree, sajna tree, benzolive tree, kelor tree, mlonge tree, and mulangay tree.[18] The *Moringa oleifera* plant, from its leaves to its seeds, pods, and flowers, possesses essential phytochemicals, offering a vast array of applications in the food, pharmaceutical, and cosmetic industries. However, leaves of *Moringa oleifera* plant have received the most attention in research due to their nutrient-rich profile, including essential amino acids and minerals like potassium, calcium, and iron. In contrast, moringa seeds contain higher fat content, approximately 42% lipids.[19] The supplementation of moringa leaf powder and extracts has been studied in a variety of food such as breads,[20] noodles,[21] cakes[22] and non-alcoholic beverages.[23]

There is a paucity of studies that use multiple approaches to evaluate and compare the consumer acceptability of biscuits prepared with millet-wheat composite flour and supplemented with two highly nutritious leaves obtained from the green tea plant and moringa tree. This study evaluated consumer preferences for healthier and fortified biscuits using sensory analysis and a preference survey among the citizens of Karachi, Pakistan. Furthermore, the functional properties of the developed biscuits were determined to correlate organoleptic scores and product functionality for commercial applications. The findings of this research would help commercialization of value added biscuits.

Material and Methods

The raw materials were procured from a local supermarket in Karachi. Wheat and millet flours were stored in zip lock bags at refrigeration condition until used.

Preparation of Moringa and Green Tea Powder

Fresh *Moringa olifera* leaves were harvested from moringa tree in University of Karachi, Karachi, Pakistan. The leaves were then thoroughly washed under running tap water and strained for 15 min to remove the excess water. Afterwards, these leaves were dried in a fluidized bed drier (TG-1 Retsch, Germany) at 60 °C for 25 min and ground to 100 mesh powder. Commercially available dried *Camellia sinensis* leaves were kept at 50 °C in a conduction oven for 20 min followed by grinding, using a kitchen grinder (AQ-923 National Romex) to prepare green tea leaves powder. Both powders were stored in zip lock bags at refrigeration temperature.

Preparation of Biscuits

The ingredients used in the formulation of biscuits are: wheat flour, pearl millet flour, sugar, hydrogenated vegetable fat, *Moringa oleifera* leaves powder, *Camellia sinensis* leaves powder and water. Both leaves powders were prepared 24 hours before incorporation in biscuits by employing method described in aforementioned section. Moreover, xanthan gum (0.12 g) was also incorporated in the samples containing pearl millet flour, to overcome the handling problems associated with the lack of gluten in millet. Four type of biscuits were prepared namely, wheat flour (WFB), pearl millet and wheat composite flour (PWB), green tea (PWGB) and moringa (PWMB) powder supplemented. Initially, the dry ingredients were mixed then fat and water was added, respectively to form a dough. The dough was then manually sheeted to an average thickness of 0.5 cm and round biscuits were shaped with the help of cookie cutter having a diameter of 6.0 cm. Afterwards, the biscuits were placed in a greased baking tray and subsequently, baked at 180 °C in a preheated conduction oven for 20 minutes. Further analyses were conducted after cooling biscuits for 15 min. at room temperature. The ratios in the formulation are given in Table 1.

Table 1: Formulation of wheat and fortified biscuits

Ingredients	WFB	PWB	PWGB	PWMB
Whole wheat flour (g)	50.0	15.0	15.0	15.0
Pearl millet flour (g)	-	35.0	31.0	31.0
Sugar (g)	30.0	30.0	30.0	30.0
Fat (g)	10.0	10.0	10.0	10.0
Water (mL)	5.0 ± 2	5.0 ±2	5.0 ±2	5.0 ±2
Green tea powder (g)	-	-	4.0	-
Moringa powder (g)	-	-	-	4.0
Xanthane gum (g)	-	0.12	0.12	0.12

Baking Weight Loss

Baking weight loss was determined in triplicate for each type of biscuit by measuring the weight (g) of one biscuit before and after baking at 180 °C. It was calculated as:

Baking weight loss (%)=(weight of biscuit before baking)/(Weight of biscuit post baking) X 100

Spread Ratio

The diameter (cm) and thickness (cm) of biscuits were determined by using a Vernier caliper then spread ratio was calculated by taking diameter to thickness ratio.[24]

Ash and Moisture Content

The standard methodologies of AACC international (2000) [25] for moisture (Method 44-40) and ash (Method 8–01) were followed.

Sensory Analysis

Sensory evaluation of traditional wheat flour and fortified non-conventional biscuits was performed with the informed consent of thirty semi trained panelists (n= 30). The panelists were screened for flu and gluten allergy. They were students and staff of Department of Food Science and Technology at University of Karachi. Assessors were explicitly briefed about the biscuit samples constituents,

parameters and practices for sensory evaluation. Then, they used a 9-point hedonic scale to score the biscuits, with 1 being extremely disliked and 9 being extremely liked. The biscuits samples were labeled with three digit random codes and served with clean drinking water, in calm environment with satisfactory daylight and ventilation. The organolepticparameters studied for all types of biscuits were colour, flavor, taste and overall acceptability.[26] Additionally, hedonic ranking obtained from the sensory analysis was categorized on the basis of gender, age range and education of assessors.

Table 2: Questions used to identify the consumers' preference of non-conventional and functional biscuits

Questions (Q)	Yes/No questions on biscuit preferences and choice
Q1	Do you consider yourself as a health conscious individual?
Q2	Do you like biscuits?
Q3	Would you like to eat biscuits containing *Moringaoleifera* leaf?
Q4	Would you like to eat biscuits containing green Tea?
Q5	Would you like to eat biscuits prepared with pearl millet (bajra) flour?

Consumer Perception

A survey was conducted by using Google forms to understand the consumer perception about fortified non-conventional biscuits in Karachi, Pakistan. Social media was employed to disseminate the questionnaire. It was explicitly mentioned in the description of questionnaire that this activity is for research purpose and limited to Karachi residents only. No incentive was offered to the participants. The data obtained from the questionnaire was categorized on the basis of gender, age range, area based on income and education. Closed ended questions mentioned in Table 2 were asked with the option of yes or no.

Statistical Analysis

For the experimental characterization, the data is mean of triplicate values whereas, for sensory evaluation mean of 30 values is presented. The data was analyzed by using one-way ANOVA and Pearson's correlation. Duncan multiple range test was applied ($p \leq 0.05$). The consumer perception is representation of 127 respondents. Descriptive, Chi-square test and spearman's correlation were employed to study the responses from survey participants. The SPSS software (version 17.0; IBM Corp., Chicago, IL, USA) was used.

Results and Discussion

Characterization of Biscuits

The mineral and moisture content of biscuits are summarized in Table 3. It could be observed that mineral content significantly increased after pearl millet flour substitution with green tea and moringa powder. The highest mineral content was found in biscuits incorporating *Moringa oleifera* flour. The moisture content of biscuits ranged between (8.2 – 14.7%) and were found in the order; PWMB<WFB<PWB<PWGB. Yadav et. alalso reported lower moisture content of biscuits prepared with moringa flower and leaves when compared to biscuits prepared wheat flour.[27]

The dimensional characterization of biscuits was carried out in terms of diameter, thickness and spread ratio. The increment in thickness during baking process is called oven rise. It is driven by the conversion of water into vapors and the generation of gases from leavening agents. The changes in thickness and diameter were reflected in spread ratio. For the quality evaluation of biscuit, spread ratio is considered as an important parameter and, in a biscuit it is defined as the ratio between diameter and height or thickness. Generally, biscuits with larger spread ratio are desirable.[28]

The spread ratio of biscuits ranged between (8.58 – 11.91), presented in Table 3. Insignificant increment in spread ratio was observed when pearl millet (PWB) and pearl millet-moringa (PWMB) was incorporated in wheat flour whereas, PWGB exhibited significantly highest spread ratio ($p \leq 0.05$). Combination of multiple flours in different ratios reflects differences in water absorption capacity and in form aggregate.[29]

This can alter the number of hydrophilic sites competing with limited water and influencing the spread ratio. Baking weight loss reflects the loss of moisture upon baking and help determining the final weight of a biscuit. The percent baking weight loss was found in the order PWGB<PWB<PWMB<WFB. The lowest moisture loss upon baking of PWGB is evident from its highest moisture content (Table 3). Lower moisture loss in wheat flour breads supplemented with moringa leaves powder is also reported in the study of Sengev *et al*.[20]

Table 3: Compositional and dimensional analysis of biscuits

Samples	Ash Content (%)	Moisture content (%)	Spread ratio	Baking weight Loss (%)
WFB	1.813±0.5^{a}	8.2433±1.1^{b}	8.582±1.5^{a}	25.7567±3.5^{d}
PWB	1.895±0.6^{b}	10.2133±2.1^{c}	9.4433±2.3^{a}	13.8633±1.6^{b}
PWGB	2.133±0.9^{c}	14.7167±2.3^{d}	11.9133±1.8^{b}	11.883±2.1^{a}
PWMB	2.856±0.7^{d}	6.8700±1.5^{a}	8.9667±1.9^{a}	20.4200±2.8^{c}

Note: WFB: Wheat flour biscuits; PWB, pearl millet and wheat composite flour; PWGB: pearl millet and wheat composite supplemented with green tea leaves; PWMB: pearl millet and wheat composite supplemented with *Moringa oleifera* leaves. Values ± standard deviation having different letters are statistically different at p<0.05.

Table 4: Sensory evaluation of wheat and fortifiedbiscuits

Samples	Colour	Flavour	Taste	Overall acceptability
WFB	7.90±0.84^{c}	7.50±1.04^{b}	8.20±0.76^{b}	8.00±1.02^{b}
PWB	7.81± 1.11^{c}	7.61±1.17^{b}	7.70±1.09^{ab}	7.77±0.817^{b}
PWGB	6.12±1.19^{a}	6.90±0.96^{a}	7.37±1.13^{a}	6.67±0.96^{a}
PWMB	7.11±1.39^{b}	7.93±0.89^{b}	7.86±0.953^{ab}	7.53±0.89^{b}

Note: WFB: Wheat flour biscuits; PWB, pearl millet and wheat composite flour; PWGB: pearl millet and wheat composite supplemented with green tea leaves; PWMB: pearl millet and wheat composite supplemented with *Moringa oleifera* leaves. Values ± standard deviation having different letters are statistically different at p<0.05.

Sensory Evaluation

Sensory or organoleptic evaluation is the assessment of a food or non-food product through the estimation of the characteristics perceptible by the five human senses such as aroma, color, noise, taste, and texture etc.[30] The humans use their senses to gather information about food from the moment they see it to the moment they swallow it and even afterwards, such as through retronasal odor and aftertaste.[31] Preference and hedonic tests fall under the category of affective sensory tests, which evaluate the acceptance of a product by naive panelists. The hedonic assessment provides immediate information on the capacity and potential for success of a newly designed product.[32] The findings of sensory analysis in terms of hedonic scores are presented in Table 4. The hedonic scores for colour (6.12 – 7.9), flavor (6.12 – 7.9), taste (7.37 – 8.20) and overall acceptability (6.67 – 8.0) were found in the liking range for traditional WFB, non-commercial millet-wheat composite biscuits and the biscuits enriched with *Moringa oleifera* leaves and green tea. However, it could be observed that colour, flavor and overall acceptability scores for the sample incorporating green tea powder were significantly smaller (p≤0.05) than scores obtained by WFB and other non-conventional biscuits samples. Lower acceptability of PWGB could be due to its significantly higher moisture content (Table 3) which could lead to a less crisp texture than other

biscuits. From the consumer's perspective, biscuits should be crispy and have a pleasant mouthfeel in order to be considered high quality.[28]

Furthermore, findings of PWGB illustrated that the darker color and bitter taste along with a specific aftertaste of PWGB was accepted only by a few panelists as evident by significantly lower hedonic scores in acceptance range. The development of bitter taste could be correlated to the existence of high concentrations of polyphenolic compounds.[33] The many psycho-physical studies showed humans combine smells and tastes and the manner these two senses interact when they are experienced together, as part of a flavor.[34] This complex interaction could be the reason of significantly lower flavor scores of PWGB while exhibiting insignificant difference in taste scores with PWB and PWMB. Moreover, the lower color scores of PWMB compared to WFB and PWB could be due to the presence of chlorophyll in the moringa leaves powder, masking the characteristic yellow color of the biscuits. A concentration-dependent decrease in color scores was observed for whole wheat leavened bread after adding dehydrated moringa powder.[35]

Consumer Perception of Fortified Nontraditional Biscuits

The difference in acceptance or rejection attitude of nontraditional biscuits was evaluated and the respondents were grouped on the basis of gender, age, education and residence in high or low income area (Table 5).

Table 5: Socio-demographic information

Demographics	Variables	Sensory analysis Frequency(%)	Questionnaire evaluation Frequency (%)
Gender	Male	46.7	38.6
	Female	53.3	61.4
Men, age	18-30	92.9	55.10
	31-40	-	28.57
	41-50	7.1	8.16
	Above 50	-	8.16
Female, age	18-30	81.3	80.76
	31-40	18.7	7.69
	41-50	-	8.97
	Above 50	-	2.56
High income area	Male	*	37.28
	Female	*	62.71
Low income area	Male	*	39.70
	Female	*	60.29
Education, Primary school	Male	-	4.08
	Female	-	-
Education, Matriculation	Male	-	4.08
	Female	-	6.41
Education, Intermediate	Male	3.3	16.32
	Female	-	11.53
Education, Undergraduate	Male	43.3	40.81
	Female	50.0	57.69
Education, Postgraduate	Male	-	34.69
	Female	3.3	24.35

*Income area was not enquired for sensory analysis participants.
- Category was not found in the data.

Table 6 (a): Frequency (%) of affirmative responses

Differences in attitude between respondents grouped on gender and income area					
Questions (Q)	**Yes-responses for all male respondents (n=49)**	**Yes-responses for all female respondents (n=78)**	**Yes-responses for all high income respon -dents (n=59)**	**Yes-responses for all low income respo -ndents (n=68)**	**Yes-responses for all respondents (n=127)**
	%[a]	%[a]	%[a]	%[a]	%[a]
Q1	81.6	71.8	77.96	73.5	75.6
Q2	91.8	88.5	94.6	89.7	89.8
Q3	55.1	52.6	54.2	52.9	53.5
Q4	28.6	33.3	38.9	25.0	31.5
Q5	53.1	60.3	59.3	55.8	57.5

Differences in attitude between respondents based on education (n=127).

Differences in attitude between respondents grouped on gender and income area					
Questions (Q)	**Yes-responses for all respondents completed primary education (n=2)**	**Yes-responses for all respondents completed matriculation (n=7)**	**Yes-responses for all respondents completed intermediate (n=17)**	**Yes-responses for all undergraduate respondents (n=65)**	**Yes-responses for all postgraduate respondents (n=36)**
	%[a]	%[a]	%[a]	%[a]	%[a]
Q1	100	71.4	70.6	80.0	69.4
Q2	100	85.7	94.1	90.7	86.1
Q3	100	57.1	52.9	55.4	47.2
Q4	100	14.3	11.8	33.8	36.1
Q5	0.0	14.3	35.3	67.6	61.1

%[a] = Percent frequency

Table 6 (b): Frequency (%) of affirmative responses

Differences in attitude between respondents grouped by age (n=127)					
Questions (Q)	**Yes-responses for all (18-30) respondents (n=90)**	**Yes-responses for all (31-40) respondents (n=20)**	**Yes-responses for all (41-50) respondents (n=11)**	**Yes-responses for all above 50 respondents (n=6)**	**Yes-responses for all respondents (n=127)**
	%[a]	%[a]	%[a]	%[a]	%[a]
Q1	75.5	85.0	72.7	50	75.6
Q2	91.1	85.0	90.9	83.3	89.8
Q3	56.6	40.0	54.5	50	53.5
Q4	31.1	25.0	36.3	50	31.5
Q5	61.1	45.0	63.6	33.3	57.5

%[a] = Percent frequency

The frequency (%) of affirmative responses are summarized in table 6a and 6b. The Q1 draws attention of the participants' perception about themselves as health considerate individuals. The major chunk (75.6%) population claimed to be health conscious. Positive association was found between high income area and health conscious attitude for both genders ($\chi 2 = 6.246$ at $p<0.012$). The Q2 affirmation suggest the popularity of biscuits among approximately 90% respondents. Insignificant spearman's correlation between income area, gender and liking of biscuits was observed suggesting the consumer acceptability of biscuits regardless of difference in living standards and gender of respondents (Table 7).

Table 7: Spearman correlation between demographic parameters and consumer perception of fortified biscuits

Parameters	Education	Age	Area	Do you consider yourself as a health conscious individual?	Do you like biscuits? containing Moringa?	Would you like to eat biscuits containing Green Tea?	Would you like to eat biscuits	Would you like to eat biscuits prepared with pearl millet (Bajra) flour?
Gender	-.031	-.255**	-.025	.111	.054	.025	-.050	-.071
Education		.239**	-.007	.049	.072	.083	-.104	-.212*
Age			-.018	.025	.066	.085	-.031	.111
Area based on income				.052	.002	.013	.150	.035
Do you consider yourself as a health conscious individual?					-.010	.096	.267**	.142
Do you like biscuits?						.102	.061	.025
Would you like to eat biscuits containing Moringa?							.292**	.093
Would you like to eat biscuits containing Green Tea?								.035

* and ** indicate significant correlation, respectively at $p\leq0.05$ and $p\leq0.01$.

Fortified biscuits could be a good choice for strategic reserves in emergency situations such as food shortages, earthquakes, and natural disasters because they are nutritious and have a longer

shelf life.[3] The Q3 and Q4 highlights the potential of functional biscuits development by employing moringa leaf and green tea powder, respectively. It was observed that more than half of the survey population (53.5%) was interested in moringa fortified biscuits whereas only 30% respondents were attracted to green tea incorporation idea in the biscuits. The willingness of people to consume novel food products and their intensity of food neophobia differs noticeably.[36] Association between age (41-50) was observed with the willingness to have green tea biscuits ($\chi 2$= 4.055 at p =0.04).

Interest in replacing wheat flour in various food products is increasing for many reasons, including its effects on human health, nutrition, and consumer demand. Common disorders related to gluten protein found in wheat, such as: allergy, sensitivity to gluten, celiac disease, and gluten sensitivity (non-celiac), have contributed to efforts to replace wheat flour.[37] Economic crises and the exploitation of indigenous resources have also led to studies on wheat alternatives. The Q5 was employed to identify the acceptability of pearl millet flour in the biscuits. It was found that 57.5% of the respondents were willing to consume biscuits prepared with pear millet flour. The finding suggested the need to highlight health and socio-economic benefits of drought-resistant millet crop among the mass population. The product acceptance among consumers with a food neophobia inclination could be improved by increasing familiarity through communication.[36] Furthermore, weak negative spearman correlation ($p<0.01$) was observed between education and willingness to eat millet grains based biscuits. This could be due to the fact that millet has a dual purpose as food and feed. It is commonly used as livestock feed and as a popular bird seed in Pakistan.[38]

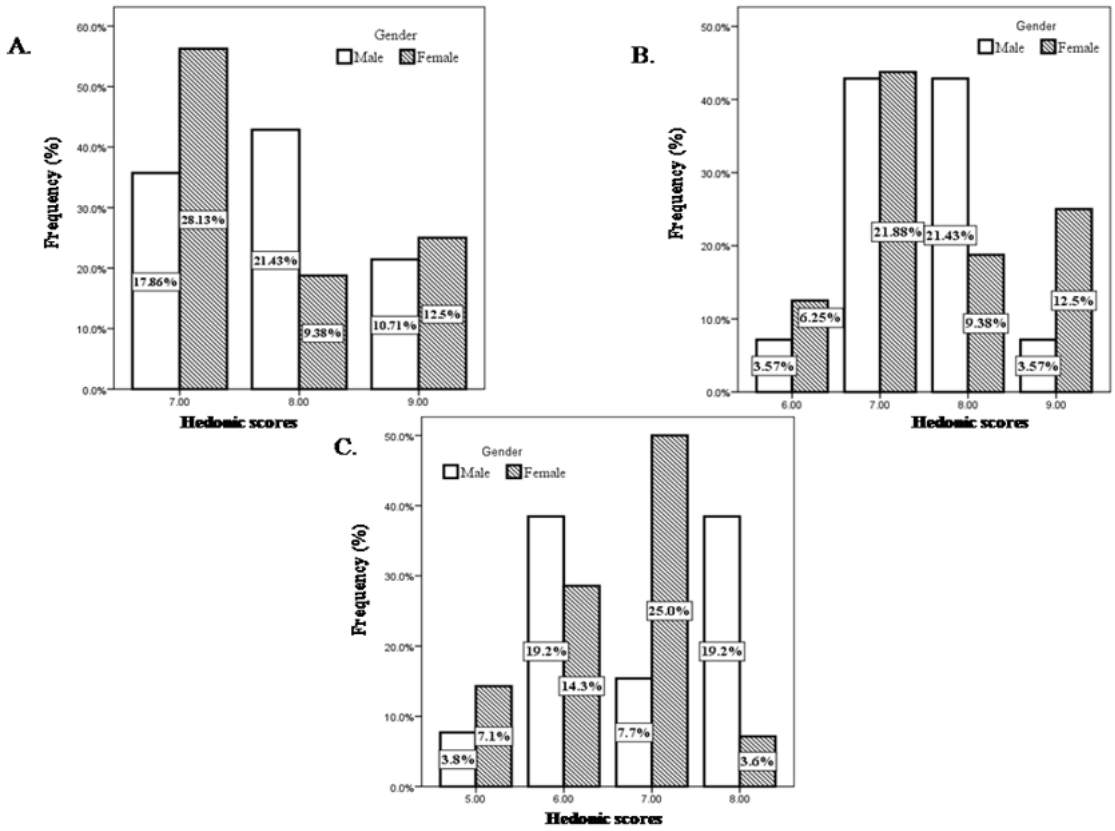

Fig. 1: Overall acceptability of non-conventional biscuits. a) Biscuits prepared with pear millet-wheat composite b) Biscuits fortified with *Moringa oleifera* leaf powder C) Biscuits fortified with green tea leaf powder

The non sensory parameters affecting the food acceptance are ease of preparation, price, production technology, consumer's health, branding, along with societal and political concerns.[39]

Interestingly, the willingness to have moringa fortified biscuits was positively correlated with the will to consume green tea supplemented biscuits. Furthermore, the willingness to eat green tea added biscuits was found positively correlated with respondent's attitude of being health concerned.

Acceptability Evaluation of Fortified Nonconventional Biscuits

The undernourished population in Pakistan for (2020-2022) is 4.8 million.[40] It is pivotal to provide sustainable and healthier options with acceptable sensory attributes to undernourished people. Figure 1 summarized the overall acceptability of biscuits having pearl millet flour, moringa leaves and green tea leaves powder. The average overall acceptability of all non-conventional biscuits were found in the consumer acceptability range i.e. greater than 5 (Table 4). However, it could be observed that only 10% male and 12% female assessors scores were in extremely liked range (9 hedonic score) for millet-wheat flour composite. Furthermore, extremely liked scoring percentage of female and male panelists were (12.5 and 3.5 %) and (3.6 and 19.2 %) for moringa and green tea enriched biscuits, respectively. The colour of biscuits was found to be positively correlated with overall acceptability at $p<0.01$ (Table 8). A weak positive Pearson's correlation ($p<0.01$) was observed between taste and flavor of the biscuits. It must be considered that 97.9 million people in Pakistan are food insecure, including 25.9 million male and 35.9 million female adults.[40] Exploring and providing non-conventional grains and nutritive alternatives with acceptable organoleptic profiles could help reduce the catastrophe of food insecurity. Moreover, incorporation of non-conventional ingredients in the formulation at relatively lower concentration might increase the ratio of extremely liked scores for overall acceptability. Increase in the supplementation level of moringa negatively affected the sensory properties of sponge cake[41] and Korean traditional rice cake.[42]

Table 8: Pearson's correlation of sensorial findings and demographics

Parameters	Flavour	Taste	Overall acceptability	Gender	Age	Education
Color	-.134	-.043	.501**	-.082	.048	.052
Flavour		.352**	.090	.157	.098	.093
Taste			.071	.082	.128	.134
Overall acceptability				-.063	.023	-.084
Gender					.049	.259**
Age						-.285**

* and ** indicate significant correlation, respectively at $p\leq0.05$ and $p\leq0.01$.

Conclusion

The findings concluded that biscuits are widely acceptable wheat based food for the population in Karachi, Pakistan. More than 50% population of the study is willing to try nonconventional options of pearl millet and *Moringa oleifera* leaf powder whereas, green was the chosen by only 30% respondents. In the sensory evaluation, the average scores of acceptability were in the range of liking which suggested the scope of fortified biscuits prepared with pearl millet and supplemented with moringa and green tea leaves powder in the food market.

Ethical Statement

All sensory panelists provided informed verbal consent for participation in the study. They were briefed about the samples, the essential practices for evaluation, and the intended use of the activity. It was optional for survey and sensory analysis participants to provide their full names and contact details. Furthermore, they were given the option to withdraw from the study after receiving the briefing and even after participation. All ingredients used for formulation of biscuits are food grade thus the biscuits used for sensory evaluation are considered

as safe for human consumption and require no additional approvals. It was explicitly mentioned on the top of survey that it is for research purpose, in bold letters.

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Conflict of Interest

The authors declare no conflict of interest.

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