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SENSORY ATTRIBUTE, PHYSICAL CHARACTERISTICS AND COST EVALUATION OF FORMULATED GLUTEN AND LACTOSE FREE MUFFIN

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ABSTRACT

Celiac is an autoimmune disorder. In recent years it has become a major public health problem. Worldwide one percent of people are affected by celiac, the count seems to be increasing every year. In India the progression of celiac is increasing day by day. In the present study, gluten and lactose free muffin was developed using locally available ingredients such as ragi flour, chickpea, banana and coconut milk. The muffins were formulated in three different proportions of ragi flour and chickpea flour labelled as sample T1 (80:20), T2 (60:40), T3 (50:50), whereas control muffin contains 100% of wheat flour. Developed product was analysed for sensory attributes using 9-point hedonic scale. The sample T1 has low acceptability score when compare to other samples. The most acceptable ratio analysed for physical characteristics such as weight, volume, specific volume, texture profile analysis and colour analysis. The weight of the muffin T3 was more… when compare to other samples. When compared to control muffin sample T2 has nearest value in both volume and specific volume. Sample T0 texture profile was most acceptable followed by sample T2 and T3. Colour of the experimental muffin was darker than control muffin. The final product cost was also calculated. The major concern of the present study was to improve the nutrient dense, and develop cost effective product also to add variety among people following special diet. The developed product is recommended for general population as well as populace with diabetic, cardiac and weight management programme.

Keywords: Celiac, Gluten, Lactose and Muffin.

I. INTRODUCTION

Celiac is an autoimmune disorder which is caused due to perpetual intolerance to gluten. Gluten is a type of protein widely distributed in wheat and its by-products. Traces of gluten was also found in rye and barley. These gluten or gluten contaminated product will damage the mucosal layer of the small intestine. It directly or indirectly leads to the malabsorption, in several cases enzyme present in small intestine aren't available for proper digestion. Hence the populace with celiac disease will have vitamin and mineral deficiencies (1) (2). Populace with lactose intolerance also facing same scenario but they are allergic to milk and milk products, in other words lactose containing products such as milk and it by product. To overcome this problem, they have to adapt to special diet. Special diet like gluten free diet and lactose free diet help an individual to reduce the health cost, improve their life expectancy. However, it increases their economic burden of the populace consuming special diet.

Baked products such as cakes, muffin, biscuits contain gluten and milk. Hence, people following special diet can not be able to consume them as such some modification…. have to be made in ingredient. In present technology, it became possible to develop gluten free or lactose free products but the final cost of the product will also increase. On the other hand, replacement of gluten free flour in baked product directly affect the colour, texture and shelf life of the final product. Likewise, replacement of cow's milk can not able to achieve its bioavailability as lactose containing milk does. Current trends and diet pattern of the people changing day by day. Due to awareness programmes and media knowledge about diet, nutritional importance of food increased the awareness among general population makes them to market search for various goods.

Gluten free and lactose free market are led by celiac and lactose intolerance patient. People with diabetic, cardiac problems and populace on weight management programme also demanding for as such products. Gluten and lactose free products was not available in local markets if, it is available also it seems to be more expensive (3). Gluten free products are 125% expensive than gluten containing product (4). Likewise, almond milk, soya milk (plant-based milk) are seem to be more expensive than lactose containing milk (5).

The ragi flour is a well know source for energy, carbohydrates, calcium and dietary fibre. But generally, cereals lack in protein. Hence to improve the protein content of the final product chickpea flour was added. Chickpea is a good source of protein, it contains all essential amino acids required for proper growth. The cereal and legume combination help to improve the nutritive value of the final product. Banana, powdered sugar and sunflower oil used for the binding and emulsification purpose. Coconut milk used as a milk replacer and also used to improve the mouth feel of the final product. Baking soda is responsible for the fluffiness of the final product. Coco powder is used as a flavouring agent. Coco flavour helps to improve the acceptancy of the final product. The ragi flour, chickpea, banana, coconut was choosen as they are locally available and also helps to decrease the cost of final product.

II. METHODOLOGY

Formulation and Preparation of muffin: The muffin was formulated in three different proportion of ragi flour and chickpea flour T1→ 80:20; T2→ 60:40; T3→ 50:50 was sample T0 contain 100% of wheat flour kept as control muffin. The preparation of muffins was represented as several steps below. Ragi flour was roasted and seived, chickpeas were dry roasted and grained into a fine powder and seived. Banana was pureed using a food processor. Coconut milk was obtained by pulverizing it with equal amount of water.

PREPARATION OF MUFFIN

STEP 1: Mix banana puree and powdered sugar

STEP 2: Add refined sunflower oil and mix

STEP 3: Add the coconut milk

STEP 4: Add dry ingredients (flour, coco powder, baking soda) cut fold into the mixture

STEP 5: Grease the mold with oil and add the batter

STEP 6: Baked at 250°C for 15 minutes

STEP 7: Cooled

Same procedure was followed to prepare all ratios such as T0, T1, T2, T3 respectively. The prepared muffins were analysed further for sensory attributes, physical characteristics, texture profile, colour analysis and cost evaluation.

Sensory attributes: The muffin was subjected for organoleptic evaluation by untrained panellist consisting of 25 members. The organoleptic evaluation was done by using 9- point hedonic scale. The most acceptable ratios were analysed further.

Physical characteristics of gluten and lactose free muffin: Physical characteristics of the muffin such as weight, volume, specific volume, texture profile analysis and colour analysis were done. Weight of the prepared samples were analysed using SF-TS200. The volume of muffin after cooling was estimated by ragi displacement method and expressed in cc. The specific volume was calculated by dividing the volume of a muffin by its weight. The average value of three replication was calculated. The result was expressed in cc/g. TPA (Texture Profile Analysis) of muffins were analysed using Texture Analyser (TA XT plus). Colour of the muffins were analysed using hunter calorimetry. Triplicate value was taken to obtain an acquired result.

Product economics: The cost of the developed product was calculated according to the procedure followed in Jain and Rai 2018 (6). The obtained value was compared with muffins available in market.

Statistical analysis: Analysis of variance (one-way), mean and stand deviation was done using SPSS software version 14.

III. RESULTS AND DISCUSSION

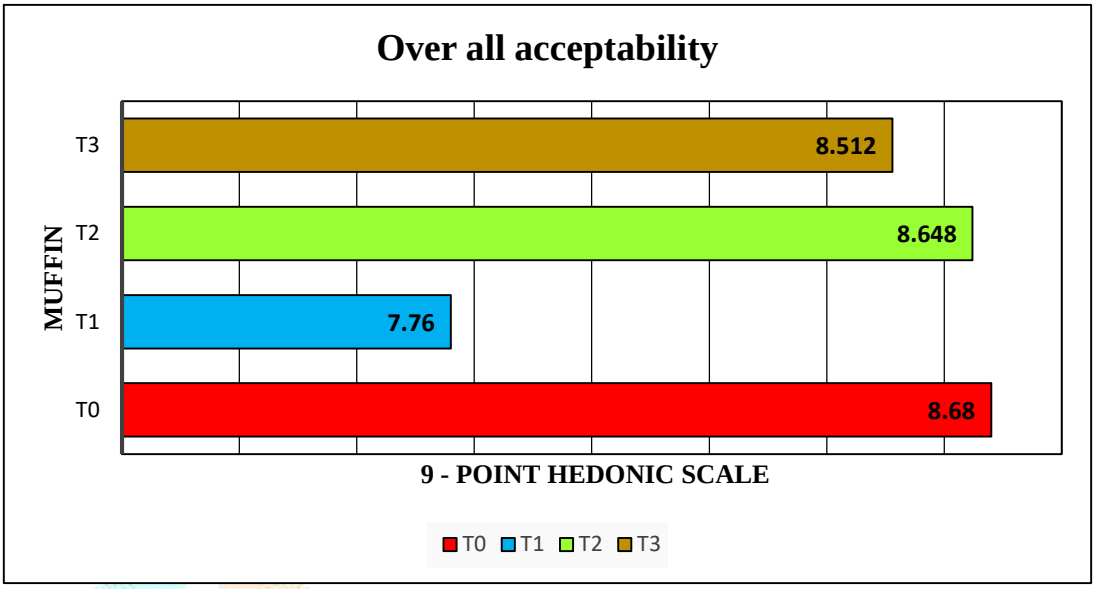
Sensory attributes: The muffin prepared with different proportion of ragi flour and chickpea flour were subjected to sensory evaluation to assess for colour, appearance, taste, texture, aroma and over all acceptability at 80:20 (T1), 60:40 (T2), 50:50 (T3) of different proportions. Results pertaining to sensory evaluation of muffin are presented in table 3.0.The table below represents the sensory attributes of gluten and lactose free muffin prepared at different ratio 80:20 (T1), 50:50 (T2), 60:40 (T3) using ragi flour and chickpea flour and control muffin made with 100% of whole wheat flour (T0). There was a significant difference among all ratios with respect to all sensory parameters. The mean score for overall acceptability of the muffin ranged from colour to texture.

Colour serve as a clue for the doneness of foods. Means for colour score amplify significant differences in muffin at different ratios. It was observed muffin T2 has highest mean score followed by muffin T3 and muffin T1. Over all the colour score ranged from 8.8±0.19 to 8.2±0.81.

Appearance is an important parameter when evaluating sensory attributes of food. Appearance of the product helps to increase the acceptancy, if the appearance of the wasn't good it is likely to be neglected. Muffin T3 has highest scoring followed by muffin T2 and T1 has a least mean score. Appearance score ranges from 8.96±0.27 to 7.68±0.47.

Taste is an important parameter when evaluating sensory attributes of food. The product might be appealing and having high energy density but without good taste, a product is likely to be rejected. Muffin T2 is found to be highly acceptable followed by muffin T3 and muffin T1. From the table it was observed muffin T1 has least scores. Mean scores for taste of gluten and lactose free muffin was significant. Changes in taste score of muffins were observed at various ratios ranges from 7.8±0.78 to 8.4±0.50.

GRAPH 3.0 OVER ALL ACCEPTABILITY OF MUFFIN T0, T1, T2, T3



Perceptions of aroma are synthesis of taste and smell impressions, along with texture and also influenced by appearance. Muffin T2 has the highest mean score, as finger millet gives the nutty flavor and taste. Means for flavor scores exhibited significant variation in gluten and lactose free muffins ranges from 7.6±0.75 to 8.6±0.47.

Texture is a combination of all sensation. The structural traits and rheology of the product perceptible by mechanical, tactile and where appropriate, visual and auditory receptors. Mean scores for texture explained a significant difference in gluten and lactose free muffins ranges from 7.5±0.82 to 8.9±0.27.

Form the graphical representation it was observed overall acceptability scores ranged from 7.76±0.50 to 8.68±0.50 there was a significant difference in all muffin at different proportions. The overall acceptability of the muffin is found to be high in T2 followed by T3 and T1 has least score. The obtained result is as same as concluded in (7), (8), (9), and (10).

TABLE 3.0 MEAN SCORE OF THE FORMULATED GLUTEN AND LACTOSE FREE MUFFIN

SENSORY ATTRIBUTES	MUFFIN				
	T0	T1	T2	T3	LS (p>0.05)
COLOUR	8.8±0.21	8.2±0.81	8.7±0.43	8.6±0.48	S
APPEARANCE	8.9±0.27	7.68±0.47	8.76±0.43	8.96±0.20	S
TASTE	8.4±0.50	7.8±0.78	8.3±0.48	8.2±0.47	S
AROMA	8.5±0.50	7.6±0.75	8.6±0.47	8.3±0.50	S
TEXTURE	8.9±0.27	7.5±0.82	8.4±0.50	8.1±0.43	S
OVERALL ACCEPTABILITY	8.6±0.50	7.76±0.50	8.64±0.30	8.51±0.25	S

LS – level of significant, NS – non-significant and S – significant.

PHYSICAL CHARACTERISTICS OF MUFFIN:

Weight, volume and specific volume: The weight of the muffin was measured using electric compact scale (SF TS200). The volume of muffin was estimated by using ragi displacement method. The specific volume was calculated by dividing the volume of a muffin by its weight (11). The specific volume of the muffin was high in sample T0, because wheat has gluten networking which helps to incorporate air inside the batter. Hence the final product weight was reduced. The sample T2 and T3 has low specific volume due to lack of gluten. The sample T2 has less specific volume. From the table 3.1 it is observed sample T3 has low volume.

TABLE 3.1 PHYSICAL CHARACTERISTICS OF MUFFIN

Muffin	Weight (g)	Volume (cc)	Specific Volume (cc/g)
T0	26.5 ±0.52	46.5±0.7	4±1.02
T2	30±0.05	46.5±1.02	3.5±0.5
T3	29±2.05	40±1.00	3.7±0.8

Texture profile analysis: Texture is an important characteristic of the baked product. The air incorporation into the batter and mixing techniques helps to improve the final texture of the product. The best acceptable muffin was analysed for texture profile. The firmness and springiness of the selected muffin was analysed using Texture Analyser (TA XT plus).

The firmness and springiness of the muffin was determined by using texture analyser TA XT plus the values are obtained. The control muffin values are significantly different when compared to trail muffins. The firmness was observed high in sample T3. The firmness of the muffin ranges from 4.03 ± 0.38 N to 10.12 ± 2.02N. Chickpea flour enriched bread, results increase in hardness (12). It resembles increase in the proportion of chickpea flour increases the hardness of the final product. Gularte, Gómez, and Rosell 2012, reported muffin developed with legume flour has greater water absorption capacity due to its greater protein and fibre contents, which decreases ability of the muffin to enclose air, resulting in a dense texture. The springiness of the control muffin was high when compare to trial muffins. The values of trial muffins were low due to the absence of gluten (13).

TABLE 3.2 TEXTURAL PROFILE ANALYSIS OF MUFFIN

TPA parameters	T0	T2	T3
Firmness (N)	4.03 ± 0.38	4.17 ± 0.62	10.12 ± 2.02
Springiness (%)	47.65 ± 1.21	46.35 ± 0.57	45.78 ± 0.57

Mean ± SD **N - newton, Ratio = 1:2**

Colour analysis: The colour of the final product helps to improve the acceptancy. The colour of the muffin was analysed by using hunter calorimetry. Muffin colour is one of the important parameters to assess the quality and acceptancy. The L*, a* and b* values for muffin crumb colour shows significant difference among control and experimental muffin (Table 3.3).

TABLE 3.3 COLOUR ANALYSIS FOR MUFFIN

Muffin	L*	a*	b*
T0	19.90	3.86	3.55
T2	19.49	3.87	3.36
T3	20.26	4.74	4.18

L* = dark – light; a* = green – red; b* = blue – yellow

Sample T0 and T2 shows less difference in colour whereas sample T2 and T3 shows wide difference in colour. The muffin made with 50:50 proportion of ragi flour and chickpea flour had low lightness (L*) than muffin made with whole wheat flour. Similarly, increase in proportion of legume flour increases the bread crumb darkness (14).

The redness (a*) of muffin made from 50:50 ratio of ragi flour and chickpea flour was high when compared to muffin made 60:40 ratio. From table 3.3, it is observed, control muffin and sample T2 has no difference in redness, same variation was observed in yellowness (b*). Low yellowness was observed in sample T2, followed by T0 and T3. Sample T3 has high yellowness when compared to other samples (table 3.3). The difference in muffin colour is because of pigments present in individual materials present in muffins and colour developed during baking process may be a cause for colour difference (15). Hallén, İbanoğlu, and Ainsworth 2004, reported legume flour (rich in lysine) increased the Millard reaction while baking process, thus decreased the lightness of the muffin made with legume-based flour.

Product economics: Various costs incurred in the production of gluten and lactose free muffin presented in the table 3.5. Total cost was divided into two parts first was raw material cost (A) and second was processing cost (B). Raw material costs for gluten and lactose free muffin include cost of ragi flour, chickpea flour, coconut milk, powdered sugar, banana, baking soda and coco powder costs. Processing costs for gluten and lactose free muffin include costs of electricity charges and labour charges. For manufacturing of 1000 grams of muffin on an average the total cost of production for muffin was Rs 29123. Table 3.5 also show the per kg production cost, for gluten and lactose free muffin it was Rs 126.6 approximately thirty-four muffins in number. Weight per muffin is approximately 30 grams. Cost per muffin is Rs 3.7.

TABLE 3.4 COST OF THE MUFFIN IN MARKET

Commercial muffins	Net. Weight	Maximum retail price (in Rs.)
Muffin A (caramel)	135 g	45
Muffin B (cream filled)	30g	25
Muffin C (plain muffin)	75 g	45
Muffin D (choco muffin)	100 g	75

The developed product cost 3.7 rupee (30 grams approx.) it includes the processing cost, electricity cost and labour cost. As compare to the muffin available in market (table 3.4) the developed product's cost was less.

One kilo grams of muffin contain 34 muffins in numbers. Hence, cost per muffin can be calculated,

$$\text{Cost per muffin} = \frac{\text{Cost per Kilo gram in rupee}}{\text{Number of muffins obtained per Kg}}$$

$$= 126.6 / 34$$

$$= 3.7 \text{ Rs. (30 grams).}$$

TABLE 3.5 COST CALCULATION OF GLUTEN AND LACTOSE FREE MUFFINS

INGREDIENTS REQUIRED	RATES	GLUTEN AND LACTOSE FREE MUFFIN	
		QUANTITY	COST
RAW MATERIAL COST (A)			
Ragi flour	72/kg	50	3600
Chickpea	50/kg	50	2500
Banana	400/kg	30	12000
Sugar	40/kg	25	1000
Coco powder	500/kg	14	7000
Baking soda	300/kg	1	300
Coconut	50/kg	30	1500
Sunflower oil	40/litre	30	1200
Total raw material		**230**	**29100**
PROCESSING COST (B)			
Electricity charges	3Rs/unit	1	3
Labour	300/8hrs	30 mins	20
Total processing cost			**23**
Total cost (A + B)			**29123**
Cost per kg			**126. 6**

CONCLUSION

The developed product in the present study has good acceptancy score. Sample T2 has high acceptancy score followed by sample T3 and T1. The most acceptable sample were T0, T2 and T3 respectively analysed further. Weight of the control muffin was less. As experimental samples weight ranges from 29.5 grams to 30.5 grams. Volume and specific volume of the muffin sample T2 exhibits nearest value to the control muffin. The texture profile parameters such as springiness and firmness of the samples were analysed. Firmness of the sample T3 was high followed by T2 and T0. Springiness of the sample T0 was good followed by T2 and T3. The developed product cost was Rs. 3.7 comparatively affordable when compared to the market available in market. Further study is required to improve the texture profile of the final product.

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