Enhanced Knowledge in Sciences and Technology Vol. 3 No. 1 (2023) 016-026

EKST

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/ekst
e-ISSN : 2773-6385

Consumer Acceptance and Physicochemical Characterization of Gluten Free Muffin Containing Pumpkin Powder and Rice Flour

Nisa Nabila Saliman[1], Nur Hafizah Malik[2*]

[1 2] Department of Technology and Natural Resources,
Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia (Pagoh Campus),
84600 Pagoh, Muar, Johor, MALAYSIA.

*Corresponding Author Designation

DOI: https://doi.org/10.30880/ekst.2023.03.01.003
Received 02 January 2023; Accepted 02 March 2023; Available online 3 August 2023

Abstract: Gluten-free muffin is suitable for people who are allergic to gluten, also known as celiac disease. High fiber muffins can be a good option to meet fiber deficiencies in gluten intolerance patients. Pumpkin is a great source of dietary fiber. Therefore, this study aims to assess consumer's possible acceptance of gluten free muffins containing pumpkin powder and rice flour. A survey was conducted to 145 respondents in determination of consumer's research on gluten free muffin and utilization of pumpkin powder in gluten free muffin. Three formulations of gluten free muffin with different ratios of pumpkin powder to rice flour (80:20, 50:50, 30:70) were developed and evaluated for their physicochemical and sensory properties. Significant difference was observed between all three formulations in terms of weight, height, moisture content and cohesiveness. Muffin made with the highest ratio of pumpkin powder exhibited the increased weight, height, moisture content and cohesiveness. However, the hardness, springiness and chewiness showed no significant effect. Colour properties measured using L*, a*, b* scale revealed that the colour of gluten free muffins containing pumpkin powder was darker, redder and more yellow than wheat muffin as the level of pumpkin powder substitution increased. Sensory evaluation based on a 9-point hedonic scale among 50 panellists showed that muffin with ratio 50:50 had the highest score in appearance, taste and overall acceptance. Thus, it was selected as preferred muffin and it had 1.4% dietary fiber per 100g of muffin which is the same as muffin made from wheat flour.

Keywords: Gluten free muffin, pumpkin powder, physicochemical, sensory, fiber

**Corresponding author: nurhafizah@uthm.edu.my*

1. Introduction

Muffin is a baked product which is individual sized. Muffin is classified as quick bread. The formulation of muffin is made up of flour, liquid, egg, sugar, salt, shortening, and baking powder [1]. Gluten is mostly found in wheat products like wheat flour [2]. Gluten is an important structure building protein in bread. Gluten is a combination of two different types of protein namely glutenin and gliadin. The function of glutenin gives wheat flour dough elasticity and strength. Glutenin when it is stretched, it resists and returns to its original shape. The function of gliadin, on the other hand, stretches easily and without resistance. When these proteins are combined, they give a dough a viscoelastic character, allowing gas to be entrapped and prevented from escaping [3]. Producing a good gluten-free bread is a technical and scientific problem due to the lack of gluten, which can result in more liquid dough and weak gas holding characteristics [4]. For muffin products, excessive gluten will cause tunnelling problems. The weight, height, appearance, colour, texture and moisture content of muffins are the most important factors in determining their physical quality.

Currently, there has been an upsurge in demand for gluten-free baked goods due to the rising awareness of celiac disease. The disease is genetically inherited and autoimmune. Patients with celiac disease only show their symptoms after they consumed food containing gluten. Their symptoms such as diarrhea, malnutrition and weight loss [5]. It is important for them to follow a strict gluten-free diet for the rest of their lives and avoid cross-contamination [6]. The main concern for gluten intolerance patients is the limited intake of dietary fiber in gluten-free diets, as well as other deficient nutrients, because wheat flour is replaced with rice flour and commercially accessible starches, resulting in lower dietary fiber intake [7]. An expert group on Malaysian Dietary Guidelines (MDG) has advised for the local population consumed 20 to 30g total dietary fiber per day [8]. The pumpkin flour has 28.3% dietary fiber [9]. The crude fiber content of fresh pumpkin is 0.56 %. The average fiber content of ripe pumpkin is 0.66 %. Pumpkin powder has 12.1g per 100g of dietary fiber [10]. Adding pumpkin powder to wheat bread can boost its nutritional value by raising dietary fiber levels [11]. Pumpkin fruit flour might be recommended as a component suited for food production with a high dietary fiber content [12].

2. Materials and Methods

2.1 Materials

Pumpkin powder, rice flour and xanthan gum were bought from a local supplier. Wheat flour, sugar, corn oil, egg, milk powder, baking powder, baking soda, salt, and artificial vanilla flavour used to produce the muffin were bought from supermarkets in Johor, Malaysia.

2.2 Survey

An online consumer survey was conducted through Google Form application to determine consumer preference on gluten free products and utilization of pumpkin powder in gluten free muffin. The questionnaire contained 20 questions and consisted of 5 different sections: (1) demographic, (2) bakery product consumption habits, (3) gluten free bakery's product, (4) utilization of pumpkin in muffin and (5) important factors in purchasing food product.

2.3 Production of muffin

Muffins were produced using four different formulations varying in the type and ratio of flour used. Control sample was prepared using wheat flour while another 3 muffins formulations were made using pumpkin powder and rice flour at ratio 80:20 (PP80), 50:50 (PP50) and 30:70 (PP30). Method used for mixing the muffin was the creaming method. Table 1 showed the formulation of each ingredient used which has been adapted and slightly modified [13].

Table 1: Formulation of control, PP80, PP50 and PP30 muffin

Ingredients	Control Sample	PP80	PP50	PP30
Wheat flour (g)	150	0	0	0
Pumpkin powder (g)	0	120	75	45
Rice Flour (g)	0	30	75	105
Water (g)	75	75	75	75
Corn Oil (g)	60	60	60	60
Egg (g)	50	50	50	50
Milk Powder (g)	11.4	11.4	11.4	11.4
Sugar (g)	60	60	60	60
Salt (g)	3	3	3	3
Artificial Vanilla Flavour (g)	0.5	0.5	0.5	0.5
Baking Powder (g)	2.5	2.5	2.5	2.5
Baking Soda (g)	1	1	1	1
Xanthan Gum (g)	0.9	0.9	0.9	0.9

Firstly, the electric oven (ORIMAS GU-6L, China) was preheated at a top temperature of 177 ºC and bottom temperature of 155 ºC. All the ingredients were prepared and weighed accordingly. Next,all the dry ingredients (wheat flour, pumpkin powder, rice flour, baking soda and baking powder) were sifted (30 mesh). Then, the eggs were whipped for 5 min using a mixer (KitchenAid, United States). Then egg, sugar, corn oil and xanthan gum were beaten together using the creaming method. The next five dry ingredients which are wheat flour, pumpkin powder, rice flour, baking powder, baking soda, salt and milk powder were combined and alternately added with water to obtain the creamed mixture. Mixing was done for about 4 min by hand. It was important to not overmix the dry or wet ingredients, so the final texture was crumbly like a muffin while still retaining air bubbles for lightness. A standard muffin cup lightly greased with corn oil. About 45g of muffin batter was weighed into each muffin cup and the tops were smoothed down for an even bake. The muffins were cooked in an electric oven with temperature 177 °C for 22 minutes [13].

2.4 Physical Properties Evaluation

2.4.1 Weight & Height

The weight of the muffin was measured using precision balance (AND GF-6100, Japan) and expressed in g. The muffin sample was measured 1 hour after baking. The height of the muffin is measured using Digital Vernier Caliper and expressed in mm. Measurements start from the bottom of each muffin to the highest top end [14].

2.4.2 Moisture Content.

The moisture content of the muffin samples was determined using the rapid moisture analyzer (A&D Company, Limited) and expressed in percentage (%). The muffin samples were broken into bits. A 1 g of ground muffin sample was placed and weighed on an aluminum pan in the rapid moisture analyzer. The heating temperature was standardized to 160°C.

2.4.3 Texture Profile Analysis (TPA)

The texture of the muffin was evaluated 1 hour after baking using a (Stable Micro System TA.XT Plus). The muffin samples have height (35 – 45mm) and weight (35-50g). Before the test run, the texture analyzer was calibrated with a 5 kg weight. A cylinder probe (P/35) with diameter of 35 mm and setting pre-test speed of 1.0 mm/sec, test speed of 2 mm/sec and post-test speed of 2 mm/sec were used. The samples of muffin were loaded in the T.A. System Software. The muffin sample was then placed in the centre of the Texture Analyzer machine. The curve obtained was used to extract the textural properties (hardness, springiness, chewiness, and cohesiveness) of the muffin.

2.4.4 Colour Analysis

MiniScan EZ Hunter Lab 4500 used to determine the colour of the muffin. All homogenized muffin samples were weighed to approximately 1-5 g in individual sample cups that had an opaque colour. The samples were compressed to obtain a smooth surface inside the cup. Before the test run, the MiniScan EZ Hunter Lab 4500 was calibrated. The colour intensity was expressed as L*, a*, and b* values, with the L* values represent the lightness range from white (100) to black (0). While the a* value represented the red (+a) or green (-a) and the b* value represented by the yellow (+b) or blue (-b) [15].

2.5 Sensory Evaluation

PP80, PP50 and PP30 were evaluated by 50 untrained panellists using a 9-point hedonic scale:1, dislike extremely; 5, neither like nor dislike; 9, like extremely. This study used a hedonic test whichis the same as the sensory method by [15]. Muffins were sliced into 8 equal parts and were served to the judges at room temperature in a zip lock bag. Before tasting the samples from each formulation, panelists were given room temperature water to rinse their mouths. Each taster was received all three samples one at a time. The appearance, texture, taste, and overall acceptance of the product were evaluated.

2.6 Determination dietary Fiber

The most preferred muffin from the sensory test used to analyse the dietary fiber content. To determine the total dietary fiber (TDF), an enzymatic–gravimetric method was used (AOAC 985.29). Homogenized muffin samples were prepared to do enzymatic digestion. Then, enzyme digestant was treated with ethanol to precipitate the soluble dietary fiber (SDF). Ethanol and acetone used to clean the filtered TDF residue. The residue was dried before being weighed. TDF values were calculated using Equation 1 after subtracting protein, ash, and reagent blank.

$$\text{TDF} = weight\ of\ residue - weight(protein + ash) \qquad \text{Eq. 1}$$

2.7 Statistical Analysis

All determinations were performed in triplicate, calculating their mean of three separate determinations. The data was statistically analysed using the software Microsoft Excel. The software of Minitab (Version 18) used to conduct an analysis of variance (ANOVA) with Tukey's test on all treatments [13].

3. Results and Discussion

3.1 Survey

There are 145 respondents from the community have participated in this survey. Respondents consisted of both males and females and ranged in age from 18 to 54 years. The majority of respondents (68.8%) feel sensible differences in gluten free products but the differences were not sensible. This contrasted with the findings [6], that the majority of respondents feel there was a sensible, reasonable, and disturbance difference between conventional wheat-based and gluten-free bread. Meanwhile, 18.8% of respondents feel no differences between gluten free product and gluten containing product. Next, the majority of respondents can accept the gluten free product (78.3%) and only 3.3% of respondents cannot accept the gluten free product. The rest of the respondents with 18.3% might accept the gluten free product. Besides, the majority of the respondents with 84.7 % accepted the idea of a gluten free muffin used pumpkin composite powder. The majority of the respondents accepted the idea that the addition of composite pumpkin powder gives health benefits with the percentage of 74.1 %. Lastly, the majority of respondents accepted the idea of gluten free muffins made from pumpkin composite powder have potential to be commercialized with 96.5%.

3.2 Physical Properties Evaluation

3.2.1 Weight & height

Table 2 showed weight and height of the muffin were significantly affected by the different formulations. At increasing amount of pumpkin powder, the weight of muffin increased. This showed that incorporation of pumpkin powder into gluten-free muffins has an impact on the final product's weight. Similar observation of bread enhanced with pumpkin flour. This could be related to pumpkin flour's increased fiber content which enhances its water absorption capacity [17]. Height is one of the most important properties of muffins [18]. The decreasing amount of pumpkin powder made the height of the gluten free muffin decrease. The reason might be because of the absence of wheat gluten in PP80, PP50 and PP30. Similarly, decreases in height and volume occurred when the muffin was made with legume-waxy rice flour blends [19]. Decrease in muffin height and volume indicates less air bubbles and poor air bubble retention capacity caused by gluten dilution [19][18] which is consistent with the number and size of air cells found in the cross section of PP80, PP50 and PP30 shown in Figure 1.

3.2.2 Moisture Content

There was a significant difference ($p < 0.05$) in moisture content between control, PP80, PP50 and PP30 muffin. The moisture content in PP80, PP50 and PP30 was lower than the control muffin. An increase in the amount of pumpkin powder in the muffins causes the moisture content to also increase. This finding was similar in a study of breads supplemented with pumpkin flour [17]. This might be attributed to the higher water absorption capacity in the pumpkin powder compared to wheat flour [20]. Water absorption capacity of the flours increased when the large amount of pumpkin flour from its pulp was replaced [20]. The higher the water absorption capacity of flour, the heavier the sample weight. This can be proved by the weight of PP80, PP50 and PP30 in Table 2. Furthermore, another reason is because of the high insoluble dietary fiber in pumpkins that can interact relatively well with large amounts of water through hydroxyl groups inherent in the fiber structure [21].

3.2.3 Texture Profile Analysis

Hardness is defined as the force required for a predetermined deformation [22]. The result wasnot significantly different ($p>0.05$) in the hardness of the muffin shown in Table 2. The hardness of PP80, PP50 and PP30 was related to the moisture content. High moisture content can increase the softness of muffins. Therefore, the increasing amount of pumpkin powder makes the muffins have a softer texture. These results are expected because most bakery items with lower volumes have higher hardness. In addition, the fiber content also affects the soft texture of bakery products [24] because pumpkin contains high fiber that strongly absorbs water resulting in muffins having a softer texture.

Cohesiveness is related to the density of the food and the amount of energy required to chew the pieces [27]. The cohesiveness between control, PP80, PP50 and PP30 were comparable as the result showed a significant difference ($p<0.05$). The control muffin was more cohesive than PP80, PP50 and PP30. The cohesiveness of a wheat-based control muffin was higher than that of a legume-containing muffin [19]. The inhomogeneity of flour mixtures of legume and waxy rice flour blends could be the reason. The cohesiveness in the control muffin represents larger specific volume and more aerated structure because gluten protein from wheat may result in a stronger and more organized gluten network. When the sample of muffin was more cohesive, it may be because it has the lowest protein content [28]. This reason is also in agreement as the cohesiveness of muffin can be improved with the incorporation of the protein isolates [29].

Freshness, lack of staling, aerated, and elasticity of product after compressive force is removedare all related to springiness [27] [30]. The result of springiness of muffin was insignificantly different ($p>0.05$) shown in Table 2. The springiness between control muffins, PP80, PP50 and PP30 was not comparable. As a result, pumpkin powder can be used as a partial substitute for rice flour because there

was no difference in springiness between the control and gluten-free muffins. Higher springiness ratings are associated with higher muffin quality [31]. PP80 has the greatest springiness than control muffin thus it has greater quality. When the pumpkin powder used in the muffin was in descending order, the springiness of muffin was decreasing [32].

The chewiness of all muffins was insignificant ($p>0.05$). The results for chewiness were closely linked to the hardness results [14]. The chewiness increased as the hardness increased shown in Table 2. This finding was similar to study of production of gluten-free cupcakes using high-protein brown rice flour, tapioca starch, and potato starch [23] and study of legume-containing gluten-free cakes as hardness and chewiness were higher than wheat flour-based control cakes [33]. The chewiness of muffins decreased when pumpkin powder was added to gluten-free muffins, similarly native Tartary buckwheat flour lowered the chewiness of muffins [30].

Table 2: Physical properties of control, PP80, PP50 and PP30

Physical Properties	Types of muffin			
	Control	PP80	PP50	PP30
Weight (g)	45.43 ± 1.33^{ab}	49.36 ± 7.32^{a}	47.67 ± 2.03^{ab}	38.69 ± 1.53^{b}
Height (mm)	43.60 ± 1.31^{a}	43.33 ± 1.07^{a}	41.70 ± 1.11^{ab}	38.87 ± 1.57^{b}
Moisture Content (%)	28.02 ± 0.35^{a}	23.16 ± 0.92^{b}	22.73 ± 2.59^{b}	22.69 ± 2.33^{b}
Hardness (N)	6.95 ± 5.00^{a}	5.60 ± 2.36^{a}	8.64 ± 1.91^{a}	9.83 ± 0.84^{a}
Cohesiveness (ratio)	0.84 ± 0.06^{a}	0.65 ± 0.14^{ab}	0.59 ± 0.03^{b}	0.63 ± 0.09^{ab}
Springiness (mm)	10.05 ± 4.19^{a}	12.06 ± 3.44^{a}	8.83 ± 1.23^{a}	9.89 ± 2.61^{a}
Chewiness (N)	46.43 ± 14.91^{a}	39.52 ± 9.66^{a}	44.17 ± 7.08^{a}	61.80 ± 21.50^{a}

Note: Data are presented as mean ± standard deviation (n = 3).
Values with different superscript letters within a row are significantly different ($p < 0.05$).

3.2.4 Colour Analysis

The (L*) and (a*) values for crumb colour showed significant differences ($p<0.05$) while (b*) values showed insignificant differences ($p>0.05$) among the tested muffins (Table 3). PP80, PP50 and PP30 had significantly lower lightness (L*) than control muffin. The colour of PP80, PP50 and PP30 were darker compared to control muffins because of the addition of pumpkin powder (Figure 1). As the amount of pumpkin powder used increased, the lightness of the bread decreased [26]. Complicated formulation makes the colour of gluten-free baked products tend to be darker [29]. The positive value of (a*) represents the red colour shown in Table 3. Similarly, gluten-free muffins containing pumpkin flour have positive (a*) value [32]. As shown in Table 3 the value of (b*) was positive, indicating yellow colour. PP30 has a larger value of (b*) than control muffins indicating that adding pumpkin powder improved the value of (b*). Similarly, bread added with pumpkin powder and basil seed gum had a more yellow colour than bread supplemented with less pumpkin powder [34]. When compared with wheat flour, the addition of pumpkin powder gives more yellow and red color. The presence of carotenoid in pumpkin powder may explain the red and yellow hues [17]. This finding is in line with addition of pumpkin to meat batters and frankfurters increases redness and yellowness [35]. Lastly, additional pumpkin powder resulted in a darker colour and higher a* and b* values [26].

Table 3: Colour of control muffn, PP80, PP50 and PP30

Colour Parameters	Types of muffin			
	Control	PP80	PP50	PP30
Lightness (L*)	67.22 ± 1.81[a]	59.53 ± 1.87[b]	58.30 ± 4.00[b]	61.19 ± 0.91[ab]
Redness (a*)	0.81 ± 0.49[a]	3.00 ± 0.86[a]	2.37 ± 0.72[a]	3.03 ± 1.30[a]
Yellowness (b*)	8.32 ± 3.09[a]	7.57 ± 1.75[a]	7.33 ± 1.95[a]	9.93 ± 3.68[a]

Note: Data are presented as mean ± standard deviation (n = 3).
Values with different superscript letters within a row are significantly different (p < 0.05).

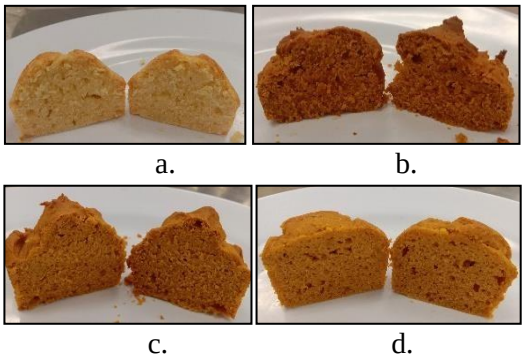

Figure 1: Cross section of muffin: a. Control; b. PP80; c. PP50; d. PP30

3.3 Sensory Evaluation

The appearance of gluten free muffin containing pumpkin powder was insignificantly different (p>0.05). This due to the appearance of PP80, PP50 and PP30 were not comparable as Table 4 shows insignificantly different (p>0.05) at (b*) value. PP80 has the lowest value (6.380) in terms of appearance while PP50 has the highest value (7.040). The texture of PP80, PP50 and PP30 in Table 4 was significantly difference (p<0.05) and comparable. PP30 has the highest value in texture (7.020) while PP80 has the lowest value (5.980). This showed that more addition of pumpkin powder made the texture of gluten free muffin become undesirable. This finding was in contrast with the study by [32] as the substitution of pumpkin flour for rice flour at 15% and above showed significant improvement (p < 0.05) on the score for crumb texture.

The taste of PP80, PP50 and PP30 was significantly different (p<0.05) and comparable. PP50 has the highest value (7.100) of taste while PP80 has the lowest value (5.820). The pumpkin flour has abundance of reducing sugars that could contribute to the sweet taste of the supplemented products [36]. However, in this study the more addition of pumpkin powder made the taste scores decreased. Similarly, beyond 20% incorporation of pumpkin powder made muffins were not acceptable by the panelists [25]. In terms of overall acceptance, the result showed significant difference (p<0.05) between the PP80, PP50 and PP30. PP50 has the highest scores (7.380) while PP80 has the lowest scores (4.860). Next, PP30 has scores (6.600). In conclusion, PP50 has the highest hedonic rate in terms of appearance, taste and overall acceptance. PP30 had the highest scores in terms of texture. In addition, PP80, PP50 and PP30 in the present work were considered acceptable by the sensory panelists, since all the muffins received scores of higher than 4 which is the same as study from [25] and [32].

Table 4: Sensory evaluation values of PP80, PP50 and PP30

Attributes	Types of muffin		
	PP80	PP50	PP30
Appearance	6.38 ± 1.44^{a}	7.04 ± 1.54^{a}	7.00 ± 1.59^{a}
Texture	5.98 ± 1.74^{b}	6.74 ± 1.70^{ab}	7.02 ± 1.42^{a}
Taste	5.82 ± 1.92^{b}	7.10 ± 1.90^{a}	7.02 ± 1.49^{a}
Overall Acceptance	4.86 ± 0.97^{c}	7.38 ± 1.24^{a}	6.60 ± 1.21^{b}

Note: Data are presented as mean ± standard deviation (n = 3). Values with different superscript letters within a row are significantly different ($p < 0.05$).

3.4 Dietary Fiber

The dietary fiber content of PP50 that has a 50:50 ratio of pumpkin powder selected from the hedonic test has been evaluated. The dietary fiber content in PP50 muffin was 1.4% per 100g of muffin sample. In a previous study, the amount of soluble dietary fiber in a control muffin made from wheat flour was 1.4% per 100g [37]. Thus, making the PP50 muffin has the same amount of dietary fiber as the muffin made with wheat flour. Moreover, the total dietary fiber in muffin made from wheat flour was 0.8% per 100g based on FoodData Central [38]. Thus, PP50 has higher fiber content than muffin made wheat flour based on USDA. The reason might be because the dietary fiber content in pumpkin powder was higher than wheat flour. The dietary fiber content per 100g of pumpkin powder was 12.1g [10] and the refined wheat flour consists of dietary fiber as low as 2% to 3% [39] which is lower than dietary fiber in pumpkin powder.

4. Conclusion

The majority of the respondents 78.3% accept gluten free bakery products and 84.7% of respondents accept the idea of utilization of pumpkin powder in gluten free muffins. The addition of pumpkin powder in gluten free muffins increases the weight, height and moisture content but decreases in chewiness, cohesiveness and hardness. The springiness between control muffin, PP80, PP50 and PP30 was not comparable. The colour of PP80, PP50 and PP30 was darker, redder and more yellow than control muffin as the level of pumpkin powder increased. From sensory evaluation, PP50 had the highest hedonic rate in terms of appearance, taste and overall acceptance while PP30 had the highest scores in terms of texture. Lastly, the dietary fiber content of gluten free muffins selected from the hedonic test (PP50) has been determined and the result obtained was 1.4% per 100g of muffin sample which is the same as muffin made from wheat flour. Thus, pumpkin powder can be incorporated in gluten free muffins as it can increase the weight, height, moisture, colour of the muffin and provide dietary fiber in gluten free products which can be consumed by gluten intolerance patients.

Acknowledgement

The authors would also like to thank the Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] S., Öztürk, and Mutlu, S., "Physicochemical properties, modifications, and applications of resistant starches", in Starches for food application, Academic Press, 2019, pp. 297-332.

[2] L.A., E.J., Pyler, Gorton, "Cake baking technology" in: Pyler, E.J. (Ed.), Baking Science and Technology. Sosland Publishing Co., Kansas, 2009, pp. 137–151.

[3] L. C. Jeffrey and A.A. William, “Gluten Intolerance, Celiac Disease, and Wheat Allergy” in Gluten-Free Baked Products, AACC International Press, 2014, pp 1-13.

[4] E., T. Ronan Gormley, Gallagher and Elke K. Arendt. "Recent advances in the formulation of gluten-free cereal-based products." Trends in Food Science & Technology 15, no. 3-4, 2004, pp. 143-152.

[5] C., Catassi et al., "Non-celiac gluten sensitivity: the new frontier of gluten related disorders." Nutrients 5.10, pp. 3839-385, 2013.

[6] V. Gyula, A. Koris, Toth, and Marcell, "Consumers’ Acceptance, Satisfaction in Consuming Gluten-free Bread: A Market Survey Approach." International Journal 8.2, pp. 44-49, 2020.

[7] M., Arslan et al., "Complimenting gluten free bakery products with dietary fiber: Opportunities and constraints." Trends in food science & technology 83, pp. 194-202, 2019.

[8] National Coordinating Committee on Food and Nutrition. Ministry of Health Malaysia. Malaysian dietary guidelines. National Coordinating Committee on Food and Nutrition, Ministry of Health Malaysia, 2010.

[9] H., Kundu et al., "Effect of incorporation of pumpkin (Cucurbita moshchata) powder and guar gum on the rheological properties of wheat flour." Journal of food science and technology 51.10, pp. 2600-2607, 2014.

[10] M. Saeleaw and G. Schleining, “Composition, physicochemical and morphological characterization of pumpkin flour”. Proceedings in ICEF11- 11th International Congress on Engineering and Food “Food Process Engineering in a Changing World”, Athens, Greece; 2011.

[11] L., Dyshlyuk et al., "In vivo study of medical and biological properties of functional bakery products with the addition of pumpkin flour." Bioactive carbohydrates and dietary fibre 12, pp. 20-24, 2017.

[12] J., Cerniauskiene et al., "Pumpkin fruit flour as a source for food enrichment in dietary fiber." Notulae Botanicae Horti Agrobotanici Cluj-Napoca 42.1, pp. 19-23, 2014.

[13] G. M., Paz et al., "High-protein rice flour in the development of gluten-free muffins." Journal of food science 85.5, pp. 1397-1402, 2020.

[14] S. C., A. N., L., Marchetti and Califano, "Partial replacement of wheat flour by pecan nut expeller meal on bakery products. Effect on muffins quality." LWT 95, pp. 85-91, 2018.

[15] Z., Zarinah et al., "Development and Physicochemical properties of Breadfruit (Artocarpus altilis) Resistant Starch Bread." Journal Of Agrobiotechnology 9.1S, pp. 182-193, 2018.

[16] L. Carmen, Nochera, and Diane Ragone, "Development of a breadfruit flour pasta product." Foods 8.3, pp. 110, 2019.

[17] E. F., W. A. See, Wan Nadiah, and A. A. Noor Aziah. "Physico-chemical and sensory evaluation of breads supplemented with pumpkin flour." International Food Research Journal 14.2, 2007.

[18] H. İbrahim Ekiz, Gökşen, and Gülden, "Use of aniseed cold-pressed by-product as a food ingredient in muffin formulation." LWT, 111722, 2021.

[19] C. Hyun-Jung, Jeong and Duyun, "Physical, textural and sensory characteristics of legume-based gluten-free muffin enriched with waxy rice flour." Food science and biotechnology 28.1, pp. 87-97, 2019.

[20] S. Esumaba, Asaam, et al., "Functional and pasting properties of yellow maize–soya bean–pumpkin composite flours and acceptability study on their breakfast cereals." Cogent Food & Agriculture 4.1, 1501932, 2018.

[21] M., de Escalada Pla et al., "Effect of immersion and turgor pressure change on mechanical properties of pumpkin (Cucumis moschata, Duch.)." Journal of the Science of Food and Agriculture 86.15, pp. 2628-2637, 2006.

[22] T. P., Guinee, "Role of protein in cheese and cheese products," in Advanced dairy chemistry—1 proteins. Springer, Boston, MA, 2003, pp. 1083-1174.

[23] S. Ricardo, Aleman et al., "High protein brown rice flour, tapioca starch & potato starch in the development of gluten-free cupcakes." LWT 152, 112326, 2021.

[24] D., Nilufer-Erdil, et al. "Effect of soy milk powder addition on staling of soy bread." Food Chemistry 131.4, pp. 1132-1139, 2012.

[25] K. Sathiya, Mala et al., "Effect of pumpkin powder incorporation on the physico-chemical, sensory and nutritional characteristics of wheat flour muffins." International Food Research Journal 25.3, pp. 1081-1087, 2018.

[26] J. Sara, G. Hosseini and Pourmohammadi, "Physicochemical, rheological, and sensorial properties of bread supplemented with pumpkin powder and basil seed gum." Journal of Food Processing and Preservation 44.12, 14739, 2020.

[27] T., Sanz et al., "Evaluation of four types of resistant starch in muffins. II. Effects in texture, colour and consumer response." European Food Research and Technology 229.2, 197-204, 2009.

[28] H. J., D., Chung and Jeong, “Physical, textural and sensory characteristics of legume-based gluten-free muffin enriched with waxy rice flour,” Food Science and Biotechnology, 28(1), pp. 87–97, 2018.

[29] J., Xu et al., "Advanced properties of gluten-free cookies, cakes, and crackers: A review." Trends in Food Science & Technology, 2020.

[30] K. Amritpal, S. Narpinder, Bhinder and Seerat, "Impact of germination on nutraceutical, functional and gluten free muffin making properties of Tartary buckwheat (Fagopyrum tataricum)." Food Hydrocolloids 124 (2022): 107268.

[31] M., Tess et al. "Physical, textural and sensory characteristics of gluten free muffins prepared with teff flour (Eragrostistef (ZUCC) trotter)." Journal of Food Processing and Technology 6.9, 2015.

[32] L. H., Ho et al. "Physical and sensory qualities of gluten-free muffin produced from composite rice-pumpkin flour." International Food Research Journal 26.3, pp. 893-901, 2019.

[33] A. Márcia, Gularte et al., "Effect of different fibers on batter and gluten-free layer cake properties." LWT-Food science and technology 48.2, pp. 209-214, 2012.

[34] A. S., D. C. Joshi and Kulkarni, "Effect of replacement of wheat flour with pumpkin powder on textural and sensory qualities of biscuit." International Food Research Journal 20.2, pp. 587, 2013.

[35] J. Cheon, Kim et al., "Effects of dietary fiber extracted from pumpkin (Cucurbita maxima Duch.) on the physico-chemical and sensory characteristics of reduced-fat frankfurters." Korean Journal for Food Science of Animal Resources 36.3, pp. 309, 2016.

[36] T., Rakcejeva et al., "Use of dried pumpkins in wheat bread production." Procedia Food Science 1, pp. 441-447, 2011.

[37] Z. Zainab, Romjaun and P. Jamuna, "Development and assessment of fibre-enriched muffins." Advances in Food Sciences 35.4, pp. 159-165, 2013.

[38] U. S. Food and Drug Administration/Center for Drug Evaluation and Research, 2020.

[39] S. Anusooya, Sivam et al., "Properties of bread dough with added fiber polysaccharides and phenolic antioxidants: A review." Journal of food science 75.8, pp. 163-174, 2010.