Food Research 7 (2) : 262 - 271 (April 2023)
Journal homepage: https://www.myfoodresearch.com

FOOD RESEARCH

FULL PAPER

The acceptability, expiration, and fibre level of gluten-free mung bean biscuits

[1,*]Fathonah, S., [1]Rosidah, [2]Iswari, R.S., [1]Amalia, B. and [1]Humaizah, S.

[1]*Culinary Department, Faculty of Engineering, Universitas Negeri Semarang, Sekaran, Gunungpati, Semarang, Indonesia*
[2]*Graduate School Program, Universitas Negeri Semarang, Indonesia*

Article history:
Received: 1 October 2021
Received in revised form: 14 November 2021
Accepted: 1 March 2022
Available Online: 18 April 2023

Keywords:
Gluten-free biscuits,
Mung beans,
Food acceptability,
Food expiration,
Fibre

DOI:
https://doi.org/10.26656/fr.2017.7(2).769

Abstract

Gluten-free mung bean biscuits have been made of mung bean flour, tapioca flour, corn starch, and egg whites. This research aimed to determine the differences amongst varied mung bean biscuit compositions and their influence on the acceptability, the measured expiration period, and the content of water and fibre. This research was conducted through a random group experiment design. Different compositions of ingredients were used, i.e., 60% mung bean flour, 15.0 - 22.5% tapioca flour, 17.5 - 25% corn starch and 7% - 10% egg whites. The packaging was made of plastics with a permeability of 0.0265 g/ m^2.day.mmHg was used. The packed biscuits were put into a jar. In the analysing process, the food acceptability was measured using a hedonic test. A further data analysis using ANOVA followed by a Duncan test was conducted to justify the acceptability of the prepared biscuits with different ingredient compositions. The expiration of the food was tested using an ASLT method. The content of water and fibre was determined using an oven method and a gravimetric analysis. This study showed that the biscuits' acceptability was in the range of 6.6–7.1 (out of 9) or the favourable scale. All the prepared biscuits showed no significant difference in the physical appearance, with slight golden yellow ($p = 0.008$) and the overall quality ($p = 0.039$). The expiration period of the gluten-free biscuits with the F5 code (20% tapioca, 20% corn starch and 7% egg whites) was 8.66 months. The water content of all prepared biscuits was very low, in the range of 0.7-2.36%, while the fibre content was very high in the range of 18.6–23.6 g.

1. Introduction

A biscuit is a product that is principally made of flour, sugar, and fat. Biscuits are often consumed with tea, coffee, and other snacks. They are consumed by all age groups of consumers and are practical to bring during travels (Mehta *et al.*, 2012; Warinporn and Savage, 2018). Biscuits are consumed by most people (Vijayalakshmi *et al.*, 2019) as well as most favoured by kids after milk (Fathonah *et al.*, 2014). Biscuits are nutritious food packed hygienically. They are sold at a competitive price, volume, and taste. The main ingredient of biscuits is wheat flour, a high energy composition with low quality.

The market of biscuits and cakes move to the healthy food market due to the increase in health incidents, media reports of human health, the increase in the awareness of physical and body lifestyle, and the increase in the cost of health services (Santos *et al.*, 2015; Trivedi and Soni, 2016). To improve the quality of biscuits, the manufacturer includes vegetable and animal protein. The rising inclusion of protein in biscuits runs in the same way with the inclusion of soybean and cassava flour (Akubor *et al.*, 2003), wheat (Nagi *et al.*, 2012), spirulina powder (Singh *et al.*, 2015), sorghum (Adiamo *et al.*, 2017), purple rice and green clams (Warinporn and Savage, 2018), green tea powder (Phongnariscorn *et al.*, 2018), and mung beans flour (Fathonah and Muvida, 2015; Fathonah *et al.*, 2019). Previous studies regarding consumer behaviour showed that the respondents were willing to eat a healthier biscuit. People appreciated the advantage of biscuit consumption made of wheat flour (Trivedi and Soni, 2016). That caused interest and created the market for gluten-free biscuits as a part of the healthy food industry (Cureton and Fasano, 2009; Houben *et al.*, 2012; Foschia *et al.*, 2016).

Previous studies also showed that mung bean biscuits contained 35% of butter with 453 kcal of energy,

*Corresponding author.
Email: *fathonah@mail.unnes.ac.id*

eISSN: 2550-2166
Published by Rynnye Lyan Resources

11.3% of protein, and 13.1% fibre. This kind of biscuit showed a high favourability (Fathonah and Sari, 2015). The best composition of the mung bean biscuits was made of 60% mung beans, 20% wheat flour, and 20% corn starch and roasted in a 17-minute heating time (Fathonah *et al.*, 2018). This composition comprised 454 kcal (7.95%) of energy, 19.75 mg of iron, and 1.94% of fibre (Setyaningsih *et al.*, 2019). The nutrition of mung bean is useful with protein content in health improvement (Du *et al.,* 2017), pro-anthocyanins for the antioxidant (Chai *et al*., 2018), and angiotensin renin for blood tension control (Yi-Shen *et al*., 2018).

Mung bean is a vegetarian food with the richest nutrition in the world (Mannay and Shadeksharasway, 2005). The high level of protein and iron is better consumed by toddlers, pregnant women, breastfeeding mothers, and anaemia survivors. In previous research, mung bean biscuits have been distributed to toddlers in an Early Childhood Education Centre in Gunung Pati, Semarang, Indonesia for a month, along with nutritional education to the parents (Fathonah *et al.*, 2019). A better understanding and improvement of kids' and their family health has been observed.

A further study regarding the replacement of wheat flour with tapioca was necessary to obtain the best quality ingredient composition. Wheat flour contains gluten which is not good for celiac survivors. Their intolerance to gluten could promote dermatitis herpetiformis, gluten ataxia, allergy, and sensitivity (Padalino *et al.*, 2016; Wolf *et al.*, 2018; Chakrabarti *et al.*, 2019). A psychological effect may occur to the survivors, such as exhaustion and anxiety (Churruca *et al.*, 2017).

Some examples of gluten-free products are biscuits made of spinach, wheat seeds, buckwheat, and peanuts (Schonlechner *et al.*, 2006), rice muffins (Matos *et al.*, 2014), and cookies made of rice and buckwheat (Sakac *et al.*, 2016). The replacement of wheat flour with gluten -free ingredients was reported earlier in the product of gluten-free cereal, like corn and rice (Lasa *et al.*, 2017).

The information on product expiration is essential for producers, consumers, distributors, and sellers. Consumers are entitled to the right to know the safety level of the products. They also have the right to know the composition of the taste, the ingredients for the looks, and the nutrition in the product. For producers, expiration is the concept of product marketing. This concept is economically important in product distribution. It is also important to the packaging of the product. For sellers and distributors, this information is extremely important to handle the stocks of food. Expiration reflects the nutrition, function, sensory profile, and safety of the food (Zielinski *et al.*, 2012). The most significant changes to food could occur in the processing, storage, and handling of lipid oxidation and microbiological decomposition. These processes reduce the quality of food and eventually lead to health dangers for consumers (Laguerre *et al.*, 2007).

Previous studies regarding biscuits' expiration period were done using various methods. The research was conducted on ten types of biscuits (five types of each local and foreign originating product) in Bangladesh kept at a temperature of 30°C and 60% RH. The result showed that the humidity of food and the water content increased over time for all samples, while the sensory value of the biscuits decreased (Chowdhury *et al.*, 2012). The use of metalized polyester polyethylene (MET-APE) -based packaging for cookies can store biscuits for four months at room temperature (Jan *et al.*, 2017). This research indicated that biscuits' expiration varied from 3 to 17.4 months.

Biscuits containing 3% of water showed a longer endurance of storability (Lean, 2006). To measure the expiration period, accelerated shelf-life testing was conducted with the approach of critical water level (Bell and Lazuda, 2000). The expiration period of biscuits or other food products was able to support the wider market. Food quality represents the properties and attributes of food. These specifications are measured using three qualifications, i.e., sensory, suitability, and healthiness (Leitzmann, 1993). In this paper, the quality of biscuits has been measured only from the acceptability, expiration, and content of water and coarse fibre. This study aimed to investigate the effect of the composition of mung bean biscuits on consumer acceptability, to measure the expiration period of the biscuits with the optimum ingredient composition, and to determine the content of water and fibre in the prepared biscuits.

2. Materials and methods

2.1 Subject of the research

The subject of this research was gluten-free biscuits with different ingredient compositions of tapioca, corn starch, and egg whites. In detail, the compositions varied in the range of 15-22.5% tapioca, 2.5% corn starch, and 7-10% egg white. The biscuits were packaged in two types of packaging, i.e., small (containing 2 biscuits) and plastic box packaging, as shown in Figure 1.

2.2 Biscuit production

This research used a random group experiment model with a three-times repetition. The composition of the ingredients used in preparing the gluten-free biscuits

https://doi.org/10.26656/fr.2017.7(2).769

Table 1. The formulas of biscuits

Biscuit ingredients	Formula (in g)							
	F1	F2	F3	F4	F5	F6	F7	F8
Mung bean Flour	360	360	360	360	360	360	360	360
Tapioca (T)	90	90	105	105	120	120	135	135
Corn starch (M)	150	150	135	135	120	120	105	105
Egg white (EW)	42	60	42	60	42	60	42	60
Butter	250	250	250	250	250	250	250	250
Sugar	250	250	250	250	250	250	250	250
Milk	60	60	60	60	60	60	60	60
Baking powder	6	6	6	6	6	6	6	6

was formulated as listed in Table 1.

The process of biscuit production follows the following steps. The granulated sugar was mixed with egg whites for 5 mins. This process continued until homogenous and was prolonged for 4 mins. The mung bean flour, wheat flour, corn starch, and baking powder were added to the egg white mixture and eventually mixed in 3 mins. The butter was added to the biscuit mould. The dough was moulded on a baking sheet for 17 min under the upper limit temperature of 150°C and lower limit temperature of 130°C. The biscuits were cooled down to room temperature for 15 mins and packed using plastics with a permeability of 0.0265 g/ m^2.days.mmHg or using a plastic box (Figure 1).

(a) (b) (c)

Figure 1. (a) Gluten-free mung bean biscuits; (b) Small plastic packs of gluten-free mung bean biscuits; (c) Gluten-free mung bean biscuits in a plastic box.

2.4 Biscuit acceptability

The acceptability of the biscuits was tested by eighty panellists. They provided scores to the biscuits using a hedonic test on the favourability scale of 1-9. A score of 1 indicated an extremely unfavourable criterion while that of 9 designated an extremely favourable criterion, as shown in Table 2 (Meilgaard *et al.*, 2007). The aspects considered in the analysis were colour, textures, sweetness, aroma, and acceptability. The panellists were required to neutralize the taste of biscuits using water after tasting each biscuit.

2.5 Analysis of nutrition

The measurement of the expiration period was done by the ASLT method. The water and fibre contents of the biscuits were measured using the oven method and gravimetric analysis, respectively (AOAC, 2010). The water content was calculated using equation (1) (Bell and Lazuda, 2000).

From the sensory test, biscuit 5 showed the best quality. The water content and isothermal water sorption of biscuit 5 were used to determine the expiration period. The critical water content was determined by storing the biscuits at 30°C in an open door without any plastic package (RH of 75 – 80%). The curve of isothermal sorption of air (ISA) was used to determine the correlation between water content and room RH. The test effectively predicted the water level of an ingredient composition under different environments. The curve of ISA was made by keeping the product in a desiccator containing saturated salts ($MgCl_2$, K_2CO_3, NaBr, NaCl, KCl, KNO_3) with different RH. There will be a water balance content (Me) after some time. Consequentially, a curve was made to relate RH and salt with the product's water content. The expiration of biscuits was measured using the date of the experiment to Equation (1), with *t* is the estimated expiration time (days), Me is water balance content (g H_2O/g solid), Mo is initial water content (g H_2O/g solid), Mc is critical water content (g H_2O/g solid), k/x is water vapour constants of permeability (g/ m^2.days.mmHg), A is an area of the package sample (m^2), Ws is the weight of the dry product (g solid), Po is saturated vapour pressure (mmHg), b is the slope of isothermal sorption curve. The expiration unit used was months with the assumption that one month was 30 days.

$$t = \frac{ln\frac{(Me - Mo)}{(ME - Mc)}}{\frac{k}{x}\left(\frac{A}{Ws}\right)\left(\frac{Po}{b}\right)} \quad (1)$$

Table 2. Biscuit acceptability criteria

No	Intervals	Acceptability
1.	1.0 – 1.8	Extremely unfavourable
2.	1.9 – 2.7	Poorly unfavourable
3.	2.8 – 3.6	Fairly unfavourable
4.	3.7 – 4.5	Unfavourable
5.	4.6 – 5.4	Neutral
6.	5.5 – 6.3	Moderately favourable
7.	6.4 – 7.2	Favourable
8.	7.3 – 8.1	Very favourable
9.	8.2 – 9.0	Extremely favourable

https://doi.org/10.26656/fr.2017.7(2).769

2.6 Data analysis

To analyse the influence of the ingredient compositions on the sensory quality and the favourability of the biscuits, factorial analysis was used. Duncan test was used to examine the difference between the acceptability of the biscuits with different compositions of ingredients (Minium *et al.*, 1993).

3. Results

An insignificant difference in the appearance of the biscuits with different ingredient compositions was observed as shown in Figure 2. A slight difference in the darker yellow colour was observed for F2, F4, and F6 biscuits. Meanwhile, F1, F3, and F5 biscuits were darker than F7 and F8 biscuits. The biscuits' acceptability ranged from 6.5 – 7.4 (Table 3) with favourable to very favourable categories. Meanwhile, the overall categories were in very favourable category. Overall, the most favourable biscuits were F3 biscuits.

Figure 2. Eight Gluten-free mung bean biscuits

The ANOVA analysis showed a significant difference between the acceptability of the gluten-free biscuits, as shown in Figure 3(a). The highlights of the difference were in the golden colour with *p* value of 0.008 and the overall acceptability with *p* value of 0.038. In detail, the colour difference could be grouped as follows: F1, F5, and F7 biscuits were different in colour from F4, F6, and F8 biscuits. They also showed different colours from F2 and F3 biscuits. There was a tendency that the higher amount of egg whites used (in F2, F6, F8 biscuits) resulted in better acceptability than the lower amount of egg white usage (in F1, F5, F7 biscuits). An exception was observed in the colour of F3 and F4 biscuits which used 17.5% tapioca and 22.5% corn starch. Generally, the acceptability of biscuits was in the range of favourable and very favourable categories. This study showed that the overall acceptability of F1, F4, F5, F6, F7, and F8 biscuits was different from that of F2 and F3 biscuits.

Table 4 shows that the water content of the eight biscuits was very low, in the range of 0.70 – 2.30%. The higher composition of tapioca was reflected in formula 6, while the lower use of corn starch is depicted in formulas 7 and 8 (Figure 3(b)). The use of egg whites did not affect the content of water and fibre. Overall, the content of fibre in the eight biscuits was very high, in the range of 18.6–23.6 g. The high level of fibre affected the texture of the biscuits. The biscuits became dry and difficult to swallow. The use of higher tapioca and lower corn starch increased the content of the fibre in the biscuits. In contrast, the content of the fibre decreased with the lower use of tapioca. Moreover, the content of total energy and protein of the F5 biscuits were 402 kcal and 9.6 g, respectively.

Table 4. Level of water and fibre on each formula

No.	Gluten-free mung bean biscuits	Water (%)	Fibre (g)
1.	Formula 1 (T 15, M 25, EW 7)	0.70	18.6
2.	Formula 2 (T 15, M 25, EW 10)	1.32	18.7
3.	Formula 3 (T 17,5, M 22,5, EW 7)	1.70	19.7
4.	Formula 4 (T 17,5, M 22,5, EW 10)	1.64	21.1
5.	Formula 5 (T 20, M 20, EW 7)	1.50	22.5
6.	Formula 6 (T 20, M 20, EW 10)	2.30	23.6
7.	Formula 7 (T 22,5, M 17,5, EW 7)	1.57	20.5
8.	Formula 8 (T 22,5, M 17,5, EW 10)	1.45	20.4
9.	Standard Biscuits 01-2973-1992	Max 5	-

T 15 = 15% tapioca, M 25 = 25% corn starch, and EW 7 = 7 % egg white

The storability of the biscuits prepared in this study was measured through a critical water content and isothermal sorption of water, as is shown in Tables 5 – 9. From these data, the expiration period of the biscuits was determined. The biscuits prepared in this study have an average expiration period of 8.66 months at 30°C with a moisture level of 55%.

Table 3. The acceptability of glutinous mung bean biscuits

Parameter	Glutinous Mung Bean Biscuits								P value
	F1	F2	F3	F4	F5	F6	F7	F8	
Colours*	6.8[a]	7.4[bc]	7.2[bc]	7.1[b]	6.8[a]	7.0[b]	6.6[a]	7.1[b]	0.008*
Aroma	6.5	6.6	6.8	6.7	6.6	6.6	6.5	6.7	0.773
Crispness	6.8	6.9	7.3	6.9	7.1	7.0	6.9	7.0	0.337
Sweetness	6.6	6.6	7.0	6.7	6.8	6.5	6.4	6.7	0.403
Taste	6.8	6.8	7.0	6.7	7.0	6.7	6.6	6.9	0.843
Overall*	6.8[a]	7.2[a]	7.3[b]	7.2[b]	7.0[a]	7.1[a]	6.7[a]	7.0[a]	0.039*
Favourability	6.7	6.9	7.1	6.8	6.9	6.8	6.6	6.9	

Values with different superscript within the same row are significantly different (P<0.05). *statistically significant

https://doi.org/10.26656/fr.2017.7(2).769

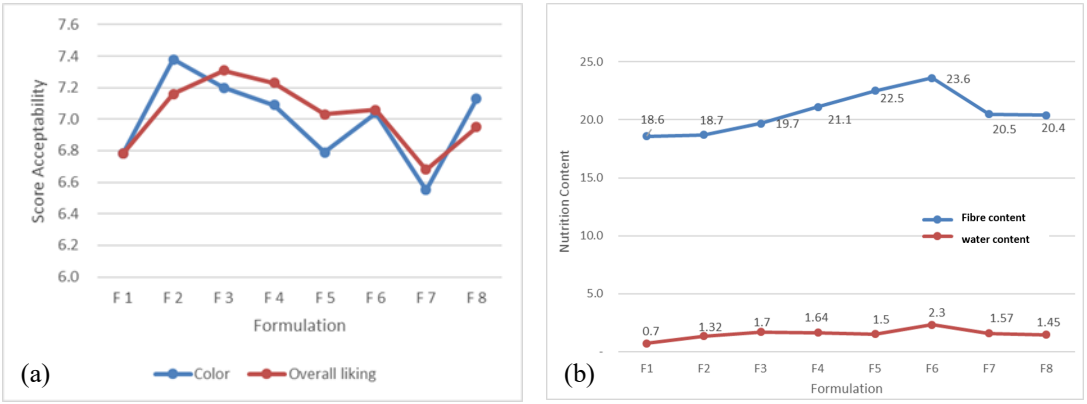

Figure 3. (a) The graph of colour and overall acceptability difference to each gluten-free mung beans biscuits formula, (b) The content of water and fibre of the biscuits

Table 5. Curve of ISA

Salts	AW	Water balance level (g H_2O/g solid)
NaOH	0.1310	0.0383
$MgCl_2$	0.3880	0.0495
KI	0.6760	0.1029
NaCl	0.7350	0.1271
KCl	0.8140	0.2006
$BaCl_2$	0.8650	0.2446
Slope		0.2547
Intercept		-0.0260

Table 6. The determination of IS

MODEL	Aw	Water balance level (g H_2O/g solid)	MRD	Slope	Intercept
Hasley	0.5500	0.1136	9.6774	0.2492	-0.0235
Chen clayton	0.5500	0.1114	35.2648	0.3062	-0.0570
Henderson	0.5500	0.0376	76.4169	0.0901	-0.0120
Caurie	0.5500	0.1114	17.3624	0.2252	-0.0124
Oswin	0.5500	0.1056	17.5440	0.2199	-0.0154
GAB	0.5500	0.1155	4.9819	0.2659	-0.0308

Note: Criteria of MRD<5 (correct), 5≤MRD≤10 (slightly correct), and MRD>10 (incorrect)

Table 7. ISA curve gab

Aw	Water balance level (g H_2O/g solid)
0.131	0.0371
0.388	0.0514
0.676	0.1004
0.735	0.1251
0.814	0.1867
0.865	0.2742

Table 8. Variable of expiration period

Parameter	Result
Initial water level (gH_2O/g solid), Mo	0.0590
Critical water level (gH_2O/g solid), Mc	0.0819
Curve slope, b model	0.2659
Packaging permeability (g/m^2.hari.mmhg), k/x	0.0265
Water level of product on storing RH (gH_2O/g solid), Me model	0.1155
Dry weight (g), Ws	11.1019
Saturated vaporized pressure (mmHg), Po	31.80
Ample (m^2), A	0.0070

Table 9. Expiration on different storing method

RH Storage (%)	55
Expiration (days)	259.72
Expiration (months)	8.66
Expiration (year)	0.72

https://doi.org/10.26656/fr.2017.7(2).769

4. Discussion

Low-gluten mung bean biscuits (20% wheat flour) and gluten-free biscuits (20% tapioca) were acceptable for consumers (Fathonah *et al.*, 2019). The replacement of wheat with tapioca worked perfectly on the biscuit production resulting in the eight biscuits with different compositions with the acceptability of 6.9 – 7.2 (out of 9) or in a good category for all indicators. The biscuits showed a good level of crispness as the main aspect of the biscuits' acceptance. The best composition of the biscuits based on the acceptability test was the F5 biscuits with 20% tapioca, 20% corn starch, and 10% egg whites.

Other studies of gluten-free biscuits showed varied acceptability levels. Gluten-free biscuits made of red rice flour (70%), corn starch (10%), potato flour (10%), and soybean flour (10%) showed the best acceptability level in the sensory level (Schober *et al.*, 2003). Rao *et al.* (2016) reported that sorghum flour resulted in a cake with a lower solidity and higher consumer acceptance. Mancebo *et al.* (2016) have developed rice-containing cookies with a higher spread factor and lower solidity. Biscuits with a composition of 50% soybean and 50% cassava showed the highest acceptability for all sensory indicators. Soybean biscuits with more than 50% soybean content showed lower acceptability (Akuabor and Ukwuru, 2004). Miranda *et al.* (2014) found that gluten-free snacks with the composition of red rice (70%), spinach flour (20%), and pear skin powder (10%) showed the best sensory in comparison with other commercial snacks. That snack also showed a low level of fat and high content of fibre and protein. Another study showed that nutritious products made of various flours (yeast, jowar, soybean, oats, corn starch, nuts) were accepted by all age groups of consumers (Mehta, *et al.*, 2012). The acceptance of gluten-free biscuits with different flours resulted in 50% for taro flour, 25% for tapioca, 15% for sorghum flour, and 10% for cassava flour (Giri and Sajeev, 2020).

The different compositions of the biscuit production resulted in different colours of the biscuits. The difference was caused by the different types of flour and different amounts of egg whites added. These flours contain different levels of carbohydrates. In this case, tapioca contains 80.0 g of carbs while corn starch has 85 g of carbohydrates (Directorate General of Public Health, 2018). The higher the level of corn starch (carbohydrate) and egg white (amino acid), the darker the colour of the products. Zanoni *et al.* (1995) reported that the development of brown colour in a biscuit crust was due to the reaction of caramelization. Caramelization is the degradation of sugar at a temperature above 150°C (Zanoni *et al.*, 1995; Hadiyanto *et al.*, 2007). This reaction known as the Maillard reaction involves the chemical conformation of the protein, amino acid, and reduced sugar to complex carbohydrates (Chung *et al.*, 2012).

The use of nuts, including mung beans has many advantages, such as containing complex carbohydrates and high levels of fibre, low levels of fat, non-cholesterol, high vitamin and mineral, and low level of sodium (Drummond and Brefere, 2004). Mung bean flour was selected to be the main composition of biscuits in this study due to its high level of protein (Stauffer, 1992). Mung bean contains vegetal protein, which is a good fat source for the human body in dissolving the vitamin and antioxidant/phytochemicals for human health (Hegazy and Ibrahim, 2009; Serrem *et al.*, 2011; Domero *et al.*, 2013). The phytochemicals in mung beans help to prevent cancer and ulcer as well as reduce cholesterol levels. The high fibre prevents a significant increase in blood sugar after fasting (Michele, 2013). The consumption of beans increased energy consumption by 250 kcal without significantly raising the bodyweight of the consumers (King *et al.*, 2008).

The expiration period of the gluten-free biscuits in this study was 8.66 months. This result was higher than other studies. In the previous study, a biscuit of bran (20%) has 3 months expiration period with a low level of microbes under HDPE and lamination (Nagi *et al.*, 2012). A study in Bangladesh showed that five local and five foreign biscuit brands were stored well for 3 months at 30°C and 60% RH. All these samples were distributable. Only one local biscuit was not tradeable. These biscuits showed a lower sensory level over time (Chowdhury *et al.*, 2012). The addition of vitamin E in cookies resulted in high acceptability and storability for 4 months (Kaur *et al.*, 2015). A sensory level is an identification to signify the expiration period of gluten-free cookies with an aldehyde (Sakac *et al.*, 2016). In this case, an unpleasant smell of food is the product of secondary lipid formation from the oxidation of biscuits. The compounds formed from that reaction could be 2-heptenal, 2-octenal, 2-nonenal, and 2,4-decadienal (Laguerre *et al.*, 2007), nonanal and 2-nonenal (Pasqualone *et al.*, 2015).

In this research, the biscuits were kept in a plastic container. Plastic is a durable, low, and cheap composition that is easily printed on all products (Nasrollahi *et al.*, 2020). The use of BOPP biaxial oriented polypropylene/casting polypropylene (BOPP_40/CPP_50 and polyethylene/ethylene vinyl alcohol/polypropylene (PE/EVOH/PP_50) could prolong the storage time of the gluten-free biscuits to 90 days on darks and lights without any change in the

https://doi.org/10.26656/fr.2017.7(2).769

physicochemical properties and sensory elements of the biscuits (Duta *et al.*, 2019).

The storability was supported by the low level of water. All compositions of the biscuits in this study showed a water content in the range of 0.70 – 2.30%, while the water content of some commercial biscuits was in the range of 1.7–5.0% (Passos *et al.*, 2013). The water content of the biscuits in this study was also lower than that of a biscuit mixed with pear porridge (Obeta *et al.*, 2020). The lower content of water made the biscuits more durable to eat with a longer expiration period, allowing the scale-up to a bigger manufacturing process.

The fibre content of the biscuits in this study was in the range of 18.6–23.6 g. In this case, the required fibre for an adult human is 38 g for 55 g of biscuits (Sizer and Whitney, 2020). This fibre content can contribute 31.0 – 39% of daily fibre needs. Referring to the data, previous studies showed various fibre contents of the products. Mung bean biscuits with wheat flour contained fibre of 4.50-4.90% (Yusuf *et al.*, 2015). 15% of spinach flour in biscuit ingredients could result in biscuits with 2.87 g of fibre (Galla *et al.*, 2017). A biscuit of corn starch (15–30 % PBF (rice and peeled black bean pre-gelatinized flour)) contained 2.03–2.07 g fibre (Bassinello *et al.*, 2011). Biscuits of wheat flour with pear porridge contained 0.47–0.84% fibre (Obeta *et al.*, 2020). There was different level of calories, macronutrients, fibre, sodium, salts, and cholesterols in 206 gluten-free products and 289 glutinous products (Miranda *et al.*, 2014). The biscuits made of wheat flour and mocaf increased the composition of cyanogen and coarse flour (Harijono *et al.*, 2017). In the end, mung bean represented the fraction of fibre food with lignin, cellulose, and hemicellulose (Mannay and Shadeksharasway, 2005). A high level of fibre is appropriate for people who require food with high fibre content. Fibre is insoluble in water. Therefore, it smooths the defecation process of the human body and prevents obstipation, haemorrhoid, and diverticulosis. Fibre could decrease the level of fat and cholesterol in the blood. Thereby, it reduces the chance of sickness, coronary heart disease, and dyslipidaemia. A study found that the increasing level of fibre intake decreased the blood pressure of hypertension survivors. The intervention should be done in 8 weeks to decrease blood level maximally (Whelton *et al.*, 2005). Fibre helps to reduce the risk of type 2 diabetes (Montonen *et al.*, 2003), and the cholesterol total and low-density lipoprotein (Brown *et al.*, 1999). A diabetes survivor should provide a dietary fibre of 25–50 g/day (15-25 g/1000 kcal) (Anderson *et al.*, 2004). Rich fibre food is positively related to the reduction of chronic diseases (Ng *et al.*, 2017). The acceptability of biscuits with the addition of fibre and combination with commercial biscuits did not show a significant difference in consumers' interest (Santos *et al.*, 2015).

Apart from the fibre, the biscuits produced in this study were high in protein (9.0–10.7 g) and energy (390–420 kcal). A distinctive energy and protein content was observed in the F5 biscuits which contained 402 kcal of energy, and 9 g of protein. Gluten-free multigrain biscuits (jowar, soybean, oats, corn starch, peanuts) contained a high content of nutrition (protein, vitamin A, calcium, and fibre). These products were highly recommended for all age groups of consumers. Biscuits are recommendable to celiac survivors, breastfeeding women, and malnutrition survivors (Mehta *et al.*, 2012).

4. Conclusion

The acceptability of gluten-free mung bean biscuits was in a very favourable category with high energy and protein content. The moisture content of the biscuits was very low and has met the standard due to a long expiration period (8.66 months), with a very high crude fibre content. These biscuits were highly recommended for consumption by all age groups, especially celiac survivors, breastfeeding women, and malnutrition survivors.

Conflict of interest

The authors declare no conflict of interest.

References

Adiamo, O.Q., Fawale, O.S. and Olawoye, B. (2017). Recent Trends in The Formulation of Gluten-free Sorghum Products. *Journal of Culinary Science and Technology,* 16(4), 311-325. https://doi.org/10.1080/15428052.2017.1388896

Akubor, P.I. and Ukwuru, M.U. (2003). Functional properties and biscuit making potential of soybean and cassava flour blends. *Plant Foods for Human Nutrition*, 58(3), 1–12. https://doi.org/10.1023/B:QUAL.0000040344.93438.df

AOAC. (2010). Official Methods of Analysis. Washington D.C, USA: AOAC International.

Anderson, J.W., Randles, K.M., Kendall, C.W.C. and Jenkins, D.J.A. (2004). Carbohydrate and Fibre Recommendations for Individuals with Diabetes: A Quantitative Assessment and Meta-Analysis of the Evidence. *Journal of the American College of Nutrition*, 23(1), 5-17. https://doi.org/10.1080/07315724.2004.10719338

Bassinello, P.Z., Freitas, D.D.G.C., Ascheri, J.L.R., Takeiti, C.Y.R., Carvalho, N., Koakuzu, S.N. and

Carvalho, A.V. (2011). Characterization of cookies formulated with rice and black bean extruded flours. *Procedia Food Science*, 1(1), 1645 – 1652. https://doi.org/10.1016/j.profoo.2011.09.243

Bell, L.N. and Lazuba, T.P. (2000). Moisture Sorption Practical Aspects of Isotherm Measurement and Use. 2nd ed. St. Paul, USA: The American Association of Cereal Chemists, Inc.

Brown, L., Rosner, B., Willettd, W.W. and Sacks, F.M. (1999). Cholesterol-lowering effects of dietary fibre: a meta-analysis. *The American Journal of Clinical Nutrition*, 69(1), 30 – 42. https://doi.org/10.1093/ajcn/69.1.30

Casiraghi M.C., Garsetti, M., Testolin, G. and Brighenti, F. (2006). Post-Prandial Responses to Cereal Products Enriched with Barley ß-Glucan. *American College of Nutrition*, 25(4), 313-320. https://doi.org/10.1080/07315724.2006.10719541

Chai, W.M., Ou-Yang, C., Huang, Q., Lin, M.Z., Wang, Y.X., Xu, K.L., Huang, W.Y. and Pang, D.D. (2018). Antityrosinase and antioxidant properties of mung bean seed proanthocyanidins: Novel insights into the inhibitory mechanism. *Food Chemistry*, 260, 27-36. https://doi.org/10.1016/j.foodchem.2018.04.001

Chakrabarti, U., Thakur, M. and Khanna, G. (2019). A Rare Case of Celiac Presenting at an Atypical Age with Multisystem Involvement. *International Journal of Celiac Disease*, 7(3), 86-89. https://doi.org/10.12691/ijcd-7-3-4

Chowdhury, K., Khan, S., Karim, R., Obaid, M. and Hasan, G.M.M.A. (2012). Quality and Shelf-Life Evaluation of Packaged Biscuits Marketed in Bangladesh. *Bangladesh Journal of Scientific and Industrial Research*, 47(1), 29-42. https://doi.org/10.3329/bjsir.v47i1.10717

Churruca, I., Larretxi, I. and Lasa, A. (2017). Gluten-Free Diet: Nutritional Status and Dietary Habits of Celiac Patients. In Nutritional and Analytical Approaches of Gluten-Free Diet in Celiac Disease. SpringerBriefs in Food, Health, and Nutrition, p. 79-94. Springer, Cham. https://doi.org/10.1007/978-3-319-53342-1_6

Cureton, P. and Fasano, A. (2009). The increasing incidence of celiac disease and the range of gluten-free products in the marketplace. In Gallagher, E. (Ed.). Gluten-free food science and technology, p. 1-15. Oxford, United Kingdom: Wiley. https://doi.org/10.1002/9781444316209.ch1

Domero, A.O., Baez, S.A., Damian, H.M.A., Rivera, T.J.A., Huerta, L.M. and Cabera, H.E. (2013). The Nutritional value of Beans (Phaseolus vulgaris L.) and its importance for Feeding of Rural communities in Puebla-Mexico. *International Research Journal in Biology Science*, 2(8), 59-65.

Drummond, K.E. and Brefere, L.S. (2014). Nutrition for Foodservice and Culinary Professionals. 5th ed. Canada: John Wiley and Sons.

Du, M., Gong, B., Xie, J. and Xu, X. (2017). Extraction, physicochemical characteristics and functional properties of Mung bean protein. *Food Hydrocolloids,* 76, 131-140. https://doi.org/10.1016/j.foodhyd.2017.01.003

Duta, D.E., Culetu, A. and Mohan, G. (2019). Sensory and physicochemical changes in gluten-free oat biscuits stored under different packaging and light conditions. *Journal of Food Science and Technology*, 56(6), 3823–3835. https://doi.org/10.1007/s13197-019-03853-z

Fathonah, S., Rosidah, R. and Sarwi, S. (2014). Nutritional Adequacy Level of Snack toward Nutritional Status of Early Childhood. *Greener Journal of Epidemiology and Public Health*, 2(2), 37-44. https://doi.org/10.15580/GJEPH.2014.2.021914118

Fathonah, S. and Sari, F. (2015). Purple Sweet Potato Biscuits with Different Margarine Usage, presented at International Conference on Green Technology, Semarang, Indonesia, 2015. Indonesia: UNNES Press.

Fathonah, S. and Muvida, F. (2015). Mung Bean Biscuits for Early Childhood, presented at 1st UNNES International Conference on Research Innovation and Commercialization for the Better Life, Semarang, Indonesia. Indonesia: LP2M.

Fathonah, S., Rosidah, R., Handoyo, A. and Rahayu, T. B. (2019). Pilot Project Intervention of Nutrition and Health Education for Mother and Provision of Energy-Dense Cookies in Early Childhood to Improve Their Nutritional Status. *Advances in Social Science, Education and Humanities Research*, 379, 143 – 149. https://doi.org/10.2991/assehr.k.191217.024

Gallagher, E., Kenny, S. and Arendt, E.K. (2005). Impact of dairy protein powders on biscuit quality. *European Food Research and Technology,* 221(2), 237–243. https://doi.org/10.1007/s00217-005-1140-5

Giri, N.A. and Sajeev, M.S. (2020). Physico-Mechanical and Nutritional Evaluation of Taro (*Colocasia esculenta*) Flour-based Gluten-free Cookies. *Agricultural Research,* 9(1), 125–131. https://doi.org/10.1007/s40003-019-00411-z

Harijono, H., Pulungan, M., Muchilisyiyah, J., Tanti, E. and Estiasih, T. (2017). Chemical Characteristics of

Biscuit Substituted by Modified Cassava Product (Mocap) Flour from High Cyanide Variety of Cassava. *Research Journal of Life Science*, 4(2), 97-105. https://doi.org/10.21776/ub.rjls.2017.004.02.2

Houben, A., Hochstotter, A. and Becker, T. (2012) Possibilities to increase the quality in gluten-free bread production: an overview. *Europian Food Research and Technology,* 235(2), 195–208. https://doi.org/10.1007/s00217-012-1720-0

Jan, R., Saxena, D.C. and Singh, S. (2017). Effect of storage conditions and packaging materials on the quality attributes of gluten-free extrudates and cookies made from germinated chenopodium (*Chenopodium album*) flour. *Journal of Food Measurement and Characterization*, 11(3), 1071–1080. https://doi.org/10.1007/s11694-017-9484-7

Kaur, M., Sandhu, K.S., Arora, A.P. and Sharma, A. (2015). Gluten-free biscuits prepared from buckwheat flour by incorporation of various gums: Physicochemical and sensory properties. *Food Science and Technology*, 62(1), 628-632. https://doi.org/10.1016/j.lwt.2014.02.039

Laguerre, M., Lecomte, J. and Villeneuve, P. (2007). Evaluation of the ability of antioxidants to counteract lipid oxidation: existing methods, new trends and challenges. *Progress in Lipid Research*, 46(5), 244 - 282. https://doi.org/10.1016/j.plipres.2007.05.002

Lasa, A., Fernández-Gil, M.D.P., Bustamante, M.Á. and Miranda, J. (2017). Nutritional and Sensorial Aspects of Gluten-Free Products. In Nutritional and Analytical Approaches of Gluten-Free Diet in Celiac Disease. SpringerBriefs in Food, Health, and Nutrition, p. 59-78. Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-319-53342-1_5

Lean, M.E.J. (2006). Fox and Cameron's Food Science, Nutrition and Health. 7th ed. London, United Kingdom: CRC Press. https://doi.org/10.1201/b13442

Leitzmann, C. (1993). Food Quality—Definition and a Holistic View. In Sommer H., Petersen B., van Wittke P. (Eds.) Safeguarding Food Quality. Berlin, Heidelberg, Germany: Springer. https://doi.org/10.1007/978-3-642-78025-7_2

Mancebo, C.M., Rodriguez, P. and Gómez, M. (2016). Assessing rice flour-starch-protein mixtures to produce gluten-free sugar-snap cookies. *LWT - Food Science and Technology,* 67, 127–132. https://doi.org/10.1016/j.lwt.2015.11.045

Mehta, K., Shivkar, S. and Shekhar, A. (2012). A Study of Multigrain Gluten-free Groundnut and Edible Gum Biscuits. *International Journal of Food and Nutritional Sciences*, 3(3), 201-206.

Meilgaard, M., Civille, G.V. and Thomas, B. (2007). Sensory Evaluation Techniques. 2nd ed. London, United Kingdom: CRC Press, Inc.

Minium, E.W., King, B.M. and Bear, G. (1993). Statistical Reasoning in Psychology and Education. 3rd ed. p 337 – 411. Canada: John Wiley and Sons, Inc.

Miranda, J., Lasa, A., Bustamante, M.A., Churruca, I. and Simon, E. (2014). Nutritional Differences Between a Gluten-free Diet and a Diet Containing Equivalent Products with Gluten. *Plant Foods for Human Nutrition*, 69(2), 182 – 187. https://doi.org/10.1007/s11130-014-0410-4

Montonen, J., Knekt, P., Järvinen, R., Aromaa, A. and Reunanen, A. (2003). Whole-grain and fibre intake and the incidence of type 2 diabetes. *The American Journal of Clinical Nutrition*, 77(3), 622–629. https://doi.org/10.1093/ajcn/77.3.622

Nagi, H., Kaur, J., Dar, B. and Sharma, S. (2012). Effect Of Storage Period and Packaging on The Shelf Life of Cereal Bran Incorporated Biscuit. *American Journal of Food Technology*, 7(5), 301-310. https://doi.org/10.3923/ajft.2012.301.310

Nasrollahi, M., Beynaghi, A., Memariyan, F. and Mozafari, M.M. (2020). Plastic Packaging, Recycling, and Sustainable Development. In Leal Filho, W., Azul, A.M., Brandli, L., Özuyar, P.G. and Wall, T. (Eds.), Responsible Consumption and Production. Encyclopedia of the UN Sustainable Development Goals. Switzerland, Cham: Springer. https://doi.org/10.1007/978-3-319-95726-5_110

Ng, S.H., Nizam, W. and Rosli, W. (2017). Incorporation of *Pleurotus sajor-caju* powder in cinnamon biscuit: study on nutritional, physical, colour and sensorial properties. *International Food Research Journal,* 24 (6), 2442-2450.

Obeta, N.A., Azike, G.C. and Asogwa, I.S. (2020). Nutritional composition, physical characteristics, and sensory attributes of wheat based biscuits enriched with bullet pear (*Canarium schweinfurthii*) fruit pulp. *Journal of Food Science and Technology*, 57 (11), 832–839. https://doi.org/10.1007/s13197-019-04114-9

Padalino, L., Conte, A. and Del Nobile, M.A. (2016). Overview on the general approaches to improve gluten-free pasta and bread. *Foods*, 5(4), 87–104. https://doi.org/10.3390/foods5040087

Passos, M.E.A.D., Moreira, C.F.F., Pacheco, M.T.B., Takase, I., Lopes, M.L.M. and Valente-Mesquita, V.L. (2013). Proximate and mineral composition of industrialized biscuits. *Food Science and*

Technology, 33(2), 323-331. https://doi.org/10.1590/S0101-20612013005000046

Pasqualone, A., Bianco, A.M., Paradiso, V.M., Summo, C., Gambacorta, G., Caponio, F. and Blanco, A. (2015). Production and characterization of functional biscuits obtained from purple wheat. *Food Chemistry*, 180, 64 -70. https://doi.org/10.1016/j.foodchem.2015.02.025

Phongnariscorn, B., Orfila, C., Holmes, M. and Marshall, L. (2018). Enrichment of Biscuits with Matcha Green Tea Powder: Its Impact on Consumer Acceptability and Acute Metabolic Response. *Foods*, 7(2), 17. https://doi.org/10.3390/foods7020017

Rao, B.D., Anis, M., Kalpana, K., Sunooj, K.V., Patil, J.V. and Ganesh, T. (2016). Influence of milling methods and particle size on hydration properties of sorghum flour and quality of sorghum biscuits. *LWT-Food Science and Technology*, 67(April), 8–13. https://doi.org/10.1016/j.lwt.2015.11.033

Sakac, M., Pestori, M., Mand, A., San, A. and Nata, C. (2016). Shelf-life prediction of gluten-free rice-buckwheat cookies. *Journal of Cereal Science*, 69, 336-343. https://doi.org/10.1016/j.jcs.2016.04.008

Santos, D., Lobo, J., Araújo, L., Deliza, R. and Marcellini, P. (2015). Free Choice Profiling, Acceptance and Purchase Intention In The Evaluation Of Different Biscuit Formulations. *Food Science and Technology,* 39(6), 613-623. https://doi.org/10.1590/S1413-70542015000600008

Schober, T.J., O'Brien, C.M., McCarthy, D., Darnedde, A. and Arendt, E.K. (2003). Influence of gluten-free flour mixes and fat powders on the quality of gluten-free biscuits. *European Food Research and Technology*, 216(5), 369–376. https://doi.org/10.1007/s00217-003-0694-3

Singh, P., Singh, R., Jha, A., Rasane, P. and Gautam, A.K. (2015). Optimization of a process for high fibre and high protein biscuit. *Journal of Food Science and Technology,* 52(3), 1394–1403. https://doi.org/10.1007/s13197-013-1139-z

Sizer, F. and Whitney, E. (2020). Nutrition: Concept and Controversies. 15th ed. USA: Cengage Learning.

Trivedi, J. and Soni, B. (2016). A Consumer Behaviour Perspective on Nutritious Biscuits. *Pacific Business Review International*, 1(1), 403-404.

Vijayalakshmi, R. and Gurumoorthy, T.R. (2019). Consumer Behaviour on Purchasing Decision of Biscuits. *International Journal of Scientific Research*, 8(1), 403-404.

Warinporn, K.W. and Savage, G. (2018). Physicochemical Properties and Sensory Evaluation of Wheat-Purple Rice Biscuits Enriched with Green-Lipped Mussel Powder (*Perna canaliculus*) and Spices. *Hindawi Journal of Food Quality*, 2018, 7697903. https://doi.org/10.1155/2018/7697903

Whelton, S.P., Hyre, A.D., Pedersen, B., Yeonjoo, Y., Whelton, P.K. and Jiang, H. (2005). Effect of dietary fibre intake on blood pressure: a meta-analysis of randomized, controlled clinical trials. *Journal of Hypertension*, 23(3), 475–481. https://doi.org/10.1097/01.hjh.0000160199.51158.cf

Yi-Shen, Z., Shuai, S. and Fitz Gerald, R. (2018). Mung bean proteins and peptides: nutritional, functional and bioactive properties. *Food Nutrition Research*, 62(1), 1290. https://doi.org/10.29219/fnr.v62.1290

Zielinski, H., del Castillo, M.D., Prygodzka, M., Ciesarova, Z., Kukurova, K. and Zielinska, D. (2012). Changes in chemical composition and antioxidative properties of rye ginger cakes during their shelf-life. *Food Chemistry*, 135(4), 2965- 2973. https://doi.org/10.1016/j.foodchem.2012.07.009

