BUKTI PROSES REVIEW

FOOD RESEARCH

Nutritional, physical and sensory properties of high protein gluten free cookies enriched resistant starch type 3 of maranta arundinaceae with flaxseed as egg replacer

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Abstract

This research aims to know nutritional, physical and sensory properties of the selected high protein gluten-free cookies enriched resistant starch type 3 of *Maranta Arundinaceae* with flaxseed as an egg replacer. The research method was done by making the three types of cookies, i.e. three types of high protein gluten-egg free cookies enriched resistant starch type 3 from Maranta arundinaceae flour cookies and one wheat cookies (as control). The research method was done with cookies formulation based on the amount of *Maranta arundinaceae* flour rich in resistant starch type 3 and a control (wheat cookies). Nutritional properties evaluation with proximate, resistant starct and diatery fiber analysis. Physical properties with spread ratio calculation and textyre analysis. The selected cookies based on a hedonic test with 80 semi-trained panelists. The selected of high protein gluten-egg free cookies enriched resistant starch type 3 of *Maranta arundinaceae* by 10.5% was formulation I that have nutritional benefit with protein content 16.84 ± 0.10%; dietary fiber 18.94 ± 0.09% and resistant starch levels 2.81 ± 0.17%. Physical properties: spread ratio 8.34 ± 0.23; texture 13.67 ± 0.22. Overall acceptance 7.56 ± 0.63. Based on the results of this research, high protein gluten free cookies could be developed as one of food for people who are sensitive to gluten and eggs.

Keywords: cookies, high protein, gluten-free, *Maranta arundinaceae*, egg replacer

1. Introduction

Cookies are associated with the source of energy and are a product that is ready to consume. Moreover, cookies can also be produced in high numbers with a short time, and it is easy to be widely distributed (Zucco et al., 2011). Indonesia has potential as a food source, i.e. tubers, legumes, cereals which can be used as a constituent of the development of gluten-free flour for making cookies. According to SNI 01-2973-1992 cookies are one of the types of biscuits made from soft dough, containing high fat, relatively crisp when broken and densely textured. According to Mamat & Hill (2014), fat in cookies serves as shortening and will affect the texture, flavor, tenderness, and mouthfeel. The essential ingredients of making cookies consist of flour with protein, fat, sugar, and eggs.

The development of gluten-free cookies is currently required in line with the growing demand for functional foods that can minimize the occurrence of allergies to constituents such as gluten and eggs. Gluten-free food products also have benefits to reduce the risk and create a type 1 diabetes mellitus

(Filbert & Sein, 2013). Gluten contained in wheat flour that is usually used for the making of cookies can be cause for people who have allergies are sensitivities on gluten (Boettcher & Crowe, 2013) and eggs (Barros & Cosme 2013). It is necessary to use egg replacer such as flaxseed (Uhlman & Schumacher, 2014). The use of food as a source of carbohydrates can be done for patients with diabetes mellitus, for example, tubers, legumes, and cereals, but the need to attempt to do the modifications so that processing can increase the levels of resistant starch (Alcazar-alay and Meireles, 2015). Resistant starch in some research can provide a positive impact on the management of the lipid and glucose profile in diabetics mellitus and improve insulin sensitivity so that it can be developed for the management of diabetes mellitus type 2 (Robertson et al., 2005). Modification technology of processing can be done by autoclaving-cooling could increase levels of RS3 on carbohydrate materials (Lilia-Baby et al., 2016).

This study aims to determine the characteristics of nutritional, physical and sensory properties of the selected high protein gluten free cookies enriched resistant starch type 3 of Maranta arundinaceae with flaxseed as an egg replacer.

2. Materials and Methods

2.1 *Materials*

Maranta arundinacea flour, brown rice flour, and soy flour obtained from local farmers in Clereng Kulon Progo, Yogyakarta, Indonesia. Tapioca flour, cornstarch, flaxseed obtained from commercial market in Yogyakarta, Indonesia. *Maranta arundinaceae* and *Coleus tuberosus* flour rich in RS3 obtained from processing modifications to autoclaving-cooling cycle 3 (Mutiara et al., 2017).

2.2. Formulation of cookies

The cookies recipe refer to a reference cookies recipe (Gisslen, 2012) with little modifications, by replacing the eggs with flaxseed, and wheat four change with high protein gluten-free flour. High protein gluten-egg free cookies rich in Maranta arundinaceae rich in RS3 made three formulations (FI, FII, and FIII). This formulation was based on the differences in the percentage of the amount of Maranta arundinaceae flour abundant in RS3. FI use 10%, F2 use 12%, using FIII using 14% (Table 1). The making of flaxseed as a eggs replacer done with flaxseed gel making. Some 10 grams flaxseed added 45 ml water, stirred and allowed in the refrigerator for 15 minutes. Constituents cookies, i.e. margarine, sugar, stir until creamy, then mix with the flaxseed gel to evenly. Then added high protein gluten-free flour, cocoa, and cheese. Cookies formed and baked with the temperature of the top 120o and bottom C 110oC during 40 minutes.

2.2. Chemical characteristics

Chemical analysis of the content of moisture, ash, fat, protein and dietary fiber using AOAC method (2005). Carbohydrate content determined by difference. Resistant starch levels established by the methods developed Englyst et al. (1992).

2.3. Physical characteristics

Cookies are taken as a random, weighted using digital scales. Thickness (height) and the diameter was measured using vernier caliper (Trickle brand, Shanghai China). Measurement of the width and diameter of the cookies was done by taking three samples. Spread ratio is calculated using the formula: diameter cookies divided thick (height) cookies (Zoulias et al., 2000). Physical

characteristics measured using cookies Liyod universal testing machine type 1000 S within 24 hours after the baking process.

2.4. Sensory evaluation

The sensory evaluation carried out by 80 people semi-trained panelists (30 men, 50 women) of students of Culinary Art Education Department, Yogyakarta State University. Evaluation based on the 9-point hedonic scale method: 1 (dislike extremely) and 9 (like extemely) and Evaluation of the cookies was done 24 hours after baking process cookies. Sensory tests carried out on four types of cookies.

2.5. Data analysis

Statistical analysis: Statistical data were analysed with SPSS version 11.0 (Illinois, USA) using one-way analysis of variance (ANOVA). Significance differences were tested using LSD. Three replications were used for chemical and physical analyses, sensory evaluation with 80 semi-trained panelis, and statistical significance was set at $p<0.05$.

3. Results and Discussion/Results

3.1. Nutritional analysis of wheat cookies (control) and high protein gluten-free cookies

As many as four kinds of cookies made in this study, i.e., control cookies made from 100% wheat flour and egg-free, and three types of high protein gluten-egg free cookies. The role of the egg was replaced by flaxseed. Flaxseed is capable of forming a gel when mixed with water, the consistency of which is constructed like the consistency of egg (Uhlman & Schumacher, 2014) and have the functional compounds, such as α-linolenic acid (ALA), dietary fiber and lignans (Hall et al., 2006).

The nutritional composition of wheat egg-free cookies (as control) and high protein gluten-egg free analyzed chemical composition (Table 2). The analysis shows that moisture content cookies range 3.24-4.64%, this meets the national standards Indonesia cookies (SNI 01-2973 2011), i.e. water content cookies under 5%. It is the moisture content of the product is still new cookies that are under 5% (Okaka, 2009). Moisture content influence on shelf life, appearance, texture, and taste of the food. Low water levels are expected to increase the shelf life of cookies. The moisture content of cookies too low will produce the burnt cookies and the colors that are too dark, whereas if moisture content is too high then the cookies generated have structures that are not too crisp and will trigger the flow of changes of flavor during storage (Manley, 2001).

The level of ash is a component that describes the levels of minerals in a given food. The higher value of ash content will be increasingly higher mineral content in it — the results of the analysis of ash levels of 3.45-4.51%. The levels of ash in the wheat cookies and gluten-egg free cookies were high enough, it is alleged to be caused by ash content of components constituting namely flaxseed (3.4%) (Ganorkar & Jain, 2013), the levels of Coleus tuberosus flour (4.4%), and all the constituents that each contain different levels of ash. A fairly high-fat content on cookies due to the contribution of margarine (17%) and fat-containing flaxseed about 41% (Ganorkar & Jain, 2013) and cheddar cheese. The fat content of cookies meet the Indonesia standard qualified quality pastries (cookies) according to SNI 01-2973-2011, i.e. a minimum fat content of 9.50%.

The protein content of high protein gluten-egg free cookies highest than wheat cookies. Protein levels on high protein gluten-egg free cookies are at 16 ± 0.10% – 17 ± 0.27%, wheat flour cookies

was 15 ± 0.05%.Protein content on all-purpose and high protein gluten-egg free cookies qualified quality pastries (cookies) according to the standard national Indonesia SNI 01-29732011, i.e. minimum protein levels by 5%. High protein cookies contain high levels of protein most affected by one of the ingredients constituting, i.e. soy flour which has a protein content of 35-39.80% (Ciabotti et al., 2016). Carbohydrate levels on high protein gluten-egg free cookies least than wheat cookies and all-purpose gluten-egg free cookies (Table 2). The difference in the levels of carbohydrates, because of the existence of a different content of protein, fat and total dietary fiber on cookies.

The difference in the amount of resistant starch of Maranta arundinaceae flour rich in RS3 levels gives an effect on gluten-egg free cookies. The levels of resistant starch on wheat cookies a lowest compared high protein gluten-free cookies eggs. RS has a functional role, not only lowers the amount of energy in food, improve digestive function, but also improve the quality of bread (Witczak et al., 2016). RS can improve elasticity and porosity of bread (Tsatsaragkou et al., 2014). Table 2 shows that the content of insoluble fiber more than soluble fiber. The difference in the content of dietary fibre on a gluten-egg free cookies and wheat flour cookies (as control) caused by ingredient of flour used which are soy four 6.70-10.70 (Ciabotti et al., 2016), brown rice 2.25%, Maranta arundinaceae 7.46±0.12%, flaxseed 28% (Ganorkar & Jain, 2013).

3.2. Physical properties

Spread ratio is one of the characteristics that are important in determining the quality of cookies. The higher the spread ratio then it will be desired and show better quality. The value of the spread ratio with a substitution of RS will be decreased. Hardness is related to the force required to break the cookies (Özboy-Özbaş, 2010). High protein gluten-free cookies have a harder texture than wheat cookies (control). Table 3 shows that the spread ratio cookies high protein gluten-free cookies have spread the smallest ratio ($p < 0.05$). Spread ratio and texture on wheat flour cookies (control) are significantly different ($p < 0.05$) than three formulations of high protein gluten-free cookies. However, the spread ratio and texture of the three formulations of high protein gluten-free cookies were not different significantly. Spread ratio shows the capabilities of cookies to inflate (Olapade & Adeyemo, 2014). The higher spread ratio indicates that the ability to inflate wheat flour cookies better than gluten-egg free cookies. The expands the capabilities associated with high protein content in wheat egg-free flour cookies. The higher the protein in flour restricts the shape. Texture results from seven cookies contained in Table 3. The hardness of texture on high protein gluten-egg free cookies related to protein content. A high protein include requires more water to get the dough good cookies, and these cookies will have even greater hardness.

3.3. Sensory properties

Sensory evaluation showed that wheat flour cookies (control) have the highest score than three types of high protein gluten-egg free cookies on the category color, aroma, flavor, texture and overall acceptance ($p < 0.05$) Table. 4 shows that the addition of a percentage of the Maranta arundinaceae rich in RS3 impact on decreasing the level of acceptance of the panelists. The existence of a replacement of some parts of the wheat flour impact on decreasing by hedonic panelists evaluations scores against a product (Yusufu et al., 2016).

Based on this research indicate that high protein gluten-egg free cookies on formulation I most preferred by the panelist (Table 5), which use Maranta arundinaceae flour rich in RS3 10% of the total ingredient of gluten-free flour. Results of this research show that the benefit of these cookies,

besides gluten-free and egg-free, but also have other advantages, namely the content of resistant starch and dietary fiber. Gluten-free cookies and eggs are enriched with resistant starch type 3 from Maranta arundinaceae could be developed into functional foods for people who are sensitive to gluten and eggs.

4. Conclusion

Types of cookies was selected for the high protein gluten-egg free cookies is a formula I with Maranta arundaceae flour rich in RS3 as much as 10% of total ingredient gluten-free flour. High protein gluten-egg cookies have characteristics most high protein, the smaller spread ratio and most hardness of texture than wheat flour cookies (as control). High protein gluten-egg free cookies contain resistant starch higher than wheat flour cookies (as control).

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

Authors would like to thanks to Directorate General of higher education for the research grants strategic competitive national with contract number 04/Penel./p. Stranas/UN 34.21/2017, 3rd April 2017.

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Table 1. Formulation of high protein gluten-free cookies with flaxseed as egg replacer

Ingredient	Wheat flour cookies as	High protein Gluten free	High protein Gluten free	High protein Gluten free

	Control (g)	cookies F I (g)	cookies F II (g)	cookies F III (g)
Wheat flour	150	-		
Gluten-free flour high protein ingredient				
Soy flour		48	48	48
Corn starch		19	19	19
Maranta arundinaceae flour		19	19	19
Tapioca flour		13	10	7
Maranta arundinaceae rich RS3		15	18	20
Coleus tuberosus flour rich in RS3		1	1	1
Brown rice flour		35	35	35
Total Gluten free flour		**150**	**150**	**150**
Margarine		90	90	90
Egg	1			
Flaxseed	-	10	10	10
Corn syrup	15	15	15	15
Salt	2	2	2	2
Cheddar cheese	75	75	75	75
Chocolate powder	5	5	5	5
Water	-	45	45	45

Tabel 2. The nutritional properties of high protein gluten-free cookies with flaxseed as egg replacer

Parameter	Control	High protein gluten-free cookies with flaxseed as egg replacer		
		FI	FII	FIII
Moisture	3,88 ± 0.07[a]	4,64 ± 0.08[c]	4.60 ± 0.03[c]	3,69 ± 0.07[b]
Ash	3,45 ± 0.07[a]	4,93 ± 0,04[b]	4,69 ± 0,18[b]	4,71 ± 0,21[b]
Lipid	31,14 ± 0,13[a]	35,12 ± 0,10[c]	35,12 ± 0,03[c]	34,23 ± 0,60[b]
Protein	15,14 ± 0.05[a]	16,85 ± 0,10[c]	17,54 ± 0,27[d]	16,34 ± 0,10[b]
Carbohydrate	25.21 ± 0,11[d]	19.50 ± 0,19[a]	20.79 ± 0,06[b]	24.42 ± 0,08[c]
Soluble dietary fiber	0,54 ± 0,12[b]	0,54± 0,08[b]	0,59 ± 0,06[c]	0,37 ± 0,06[a]
Insoluble dietary fiber	20,56 ± 0,16[d]	18.40± 0.11[c]	16.66 ± 0,13[b]	16.16 ± 0,05[a]
Resistant starch	2,18 ± 0,18[a]	2,81 ± 0,17[b]	3,39 ± 0,07[c]	4.97 ± 0,08[d]

Tabel 3. Physical characteristics wheat cookies, wheat flour cookies (WH-C), and high protein gluten-free cookies with flaxseed as egg replacer (HP-GFC)

Cookies type	Weight (gram)	Diameter (mm)	Height (mm)	Spread ratio	Texture
WH-C	1.51±0.02^{b}	33.99±0.13^{a}	3.51±0.03^{a}	9.69±0.09^{b}	12.24±0.25^{a}
HP-GFC FI	1.11±0.02a	31.47±0.20^{b}	3.77±0.09^{b}	8.34±0.23^{a}	13.67±0.22^{b}
HP-GFC FII	1.11±0.02^{a}	31.50±0.26^{b}	3.79±0.07^{b}	8.32±0.24^{a}	13.84±0.12^{b}
HP-GFC FIII	1.11±0.02^{a}	31.48±0.21^{b}	3.79±0.09^{b}	8.32±0.24^{a}	14.02±0.14^{b}

Values are the Mean±SD, different superscripts in the same row are significantly different ($p<0.05$)

Table 4. Sensory characteristics of wheat flour cookies (control), and high protein gluten-free cookies with flaxseed as egg replacer

Characteristic	Wheat cookies	High Protein gluten-free cookies		
		FI	FII	FIII
Aroma	8,01 ± 0,58[c]	7.55 ± 0.67[b]	7.23 ± 0.73[a]	7.19 ± 0.68[a]
Color	7,93 ± 0,67[c]	7.40 ± 0.77[b]	7.21 ± 0.74[a]	7.06 ± 0.79[a]
Taste	7,89 ± 0,50[c]	7.56 ± 0.73[b]	7.29 ± 0.78[a]	7.29 ± 0.78[a]
Crispness	7,82 ± 0,55[b]	7.71 ± 0.56[c]	7.14 ± 0.65[a]	6.98 ± 0.75[a]
Overall aceptability	7,90 ± 0,54[c]	7.58 ± 0.63[b]	7.23 ± 0.69[a]	7.14 ± 0.71[a]

Values are the Mean±SD, different superscripts in the same row are significantly different ($p<0.05$)

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FR-2019-145

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Date	:	4th April 2019
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Please return by	:	11th May 2019
Title of Manuscript	:	Nutritional, physical and sensory properties of high protein gluten free cookies enriched resistant starch type 3 of maranta arundinaceae with flaxseed as egg replacer

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3.	**Keywords** *Min. 3 and Max. 6* Suggest changing 'egg replacer' with flaxseed. Be direct and specific as it should represent the novelty of the paper.	Egg Replacer has been changed to Flaxseed

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5.	**Research design/Methodology** *Clearly described and reproducible* Ok	
6.	**Data Analysis** *Results well presented and discussed* Results were presented fine and discussed. But there is a concern as the favoured cookie was still the cookie made with wheat cookie by the 80 panelists and the sensory analysis showed the scores were significantly different. The author should justify of such results. There is insufficient justification on this.	It has been revised and added information to explain more in the assembled with the texture of cookies produced on this research and supported by reference. It is on line 167. The results of research using semi-trained panelists have been clearly detailed. A significant difference between the four types of cookies made has been explained. It is in line 186.
7.	**Conclusion** *A clear summary of the study* The results of the study was summarized briefly without any figures, which is too brief. The author should also recommend on how to make the cookie more acceptable in the conclusion by giving some recommendations. Although it is nutritionally benefitting, but the quality in terms of taste is missing. Hence, the author should recommend steps/ways to make the author with higher acceptance.	The results of this research show that overall aceptability of the best cookies are formulation I belong to the category like very much, so these cookies can be developed and commercialized for people who are sensitive to gluten or eggs. Nevertheless, it can be attempted to increase overalls aceptability to the gluten-free cookies by lowering the number of percentages of Maranta Arundinaceae flour Rich in RS3 used (10%)...It is in line 215
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Nutritional, physical and sensory properties of high protein gluten and egg-free cookies enriched with resistant starch type 3 of *Maranta arundinaceae* and flaxseed

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Abstract

This research was aimed to study on the nutritional, physical and sensory properties of the selected high protein gluten-free cookies enriched resistant starch type 3 of *Maranta arundinaceae* with flaxseed as an egg replacer. The research method was done by making different cookies formulation based on the amount of *M. arundinaceae* flour enriched with resistant starch type 3 were developed. Cookies made with wheat flour was used as control. Cookies formulation based on the amount of *Maranta arundinaceae* flour rich in resistant starch type 3 and a control (wheat cookies). Proximate analysis, resistant starch and dietary fiber analysis were used to evaluate the nutritional properties of the cookie while the physical properties were evaluated based on the spread ratio and texture analysis. Physical properties with spread ratio calculation and texture analysis. The best cookies based on a hedonic test with 80 semi-trained panelists. The best high protein gluten-egg free cookies were made with 10.5% resistant starch type 3 with the following: 16.84±0.10% protein content; 18.94 ± 0.09% dietary fiber and 2.81 ± 0.17% resistant starch levels. Physical properties: spread ratio 8.34 ± 0.23; texture 13.67 ± 0.22. Overall acceptance 7.56 ± 0.63. Based on the results of this research, The developed high protein gluten free and egg free cookies will be beneficial for those who are sensitive to gluten and eggs.

Keywords: cookies, high protein, gluten-free, *Maranta arundinaceae*, flaxseed

1. Introduction

Cookies are associated with the source of energy and are a product that is ready to consume. Moreover, cookies can also be produced in high numbers with a short time, and it is easy to be widely distributed (Zucco et al., 2011). Indonesia has potential as a food source, i.e. tubers, legumes, cereals which can be used as a constituent of the development of gluten-free flour for making cookies. According to SNI 01-2973-1992, cookies are one of the types of biscuits made from soft dough, containing high fat, relatively crisp when broken and densely textured. According to Mamat and Hill (2014), fat in cookies serves as shortening which affect the texture, flavor, tenderness, and mouthfeel. The essential ingredients of making cookies consist of flour with protein, fat, sugar, and eggs.

The development of gluten-free cookies is currently required in line with the growing demand for functional foods that can minimize the occurrence of allergies to constituents such as gluten and eggs. Gluten-free food products also have benefits to reduce the risk and create a type 1 diabetes mellitus (Filbert and Sein, 2013). Gluten contained in wheat flour is usually used for the making of cookies can be an issue for people who are allergic to gluten (Boettcher and Crowe, 2013). Making cookies that use eggs, can also cause allergies in sensitive people because the egg is one of the allergens (Barros and Cosme 2013), so that It is necessary to use egg replacer such as flaxseed (Uhlman and Schumacher, 2014). The use of food as a source of carbohydrates can be done for patients with diabetes mellitus, for example, tubers, legumes, and cereals, but the need to attempt to do the modifications in the processing to increase the levels of resistant starch (Alcazar-alay and Meireles, 2015). Resistant starch can provide a positive impact on the management of the lipid and glucose profile in diabetics mellitus and improve insulin sensitivity so that it can be developed for the management of diabetes mellitus type 2 (Robertson *et al.,* 2005). Resistant starch can be produced by autoclaving-cooling could increase levels of RS3 on carbohydrate materials (Lilia-Baby *et al.,* 2016).

High protein Gluten-free cookies enriched with resistant starch type 3 of *M. arundinaceae* is a new product that has a composition of different constituent materials with wheat cookies that are currently sold to consumers. The difference in composition of the composition material can affect the characteristics of the cookies, not only nutrients, physical, but also sensory properties. The development efforts of high protein gluten-free cookies enriched with resistant starch type 3 into functional food directed at the commercialization of the product, must be supported with clear information related to nutrition, physical and sensory properties. So it is necessary to further research to find out the formulation impact of high protein gluten-free cookies enriched with resistant starch type 3 to the characteristics of the cookies.

This study is aimed to determine the characteristics of nutritional, physical and sensory properties of the high protein gluten free cookies enriched resistant starch type 3 of *M. arundinaceae* with flaxseed as an egg replacer.

2. Materials and Methods

2.1 *Materials*

M. arundinacea flour, brown rice flour, and soy flour obtained from local farmers in Clereng Kulon Progo, Yogyakarta, Indonesia. Tapioca flour, cornstarch, flaxseed obtained from commercial market in Yogyakarta, Indonesia. *M. arundinaceae* and *Coleus tuberosus* flour rich in RS3 was produce by 3 - cycle autoclaving-cooling (Mutiara *et al.,* 2017).

2.2. Formulation of cookies

The cookies recipe refer to a reference cookies recipe (Gisslen, 2012) with little modifications, by replacing the eggs with flaxseed, and wheat four change with high protein gluten-free flour. High protein gluten-egg free cookies rich in *M. arundinaceae* rich in RS3 made three formulations (FI, FII, and FIII). This formulation was based on the differences in the percentage of the amount of *M. arundinaceae* flour abundant in RS3. FI use 10%, F2 use 12%, using FIII using 14% (Table 1). The making of flaxseed as a eggs replacer done with flaxseed gel making. Some 10 grams flaxseed added 45 ml water, stirred and allowed in the refrigerator for 15 minutes. Constituents cookies, i.e.

margarine, sugar, stir until creamy, then mix with the flaxseed gel to evenly. Then added high protein gluten-free flour, cocoa, and cheese. Cookies formed and baked with the temperature of the top 120^{o}C and bottom 110^{o}C during 40 minutes.

2.2. Chemical characteristics

Chemical analysis of the content of moisture, ash, fat, protein and dietary fiber using AOAC method (2005). Carbohydrate content determined by difference. Resistant starch levels established by the methods developed Englyst *et al.* (1992).

2.3. Physical characteristics

Cookies are taken as a random, weighted using digital scales. Thickness (height) and the diameter was measured using vernier caliper (Trickle brand, Shanghai China). Measurement of the width and diameter of the cookies was done by taking three samples. Spread ratio is calculated using the formula: diameter cookies divided thick (height) cookies (Zoulias *et al.,* 2000). Physical characteristics measured using cookies Liyod universal testing machine type 1000 S within 24 hours after the baking process.

2.4. Sensory evaluation

The sensory evaluation carried out by 80 people semi-trained panelists (30 men, 50 women) of students of Culinary Art Education Department, Yogyakarta State University. Evaluation based on the 9-point hedonic scale method: 1 (dislike extremely) and 9 (like extremely) and Evaluation of the cookies was done 24 hours after baking process cookies. Sensory tests carried out on four types of cookies.

2.5. Statistical analysis

Data were analysed with SPSS version 11.0 (Illinois, USA) using one-way analysis of variance (ANOVA). Significant differences were tested using LSD. Three replications were used for chemical and physical analyses, sensory evaluation with 80 semi-trained panelis, and statistical significance was set at $p<0.05$.

3. Results and Discussion/Results

3.1. Nutritional analysis of wheat cookies (control) and high protein gluten-free cookies

As many as four kinds of cookies made in this study, i.e., control cookies made from 100% wheat flour and egg-free, and three types of high protein gluten-egg free cookies. The role of the egg was replaced by flaxseed. Flaxseed is capable of forming a gel when mixed with water, the consistency of which is constructed like the consistency of egg (Uhlman and Schumacher, 2014) and have the functional compounds, such as α-linolenic acid (ALA), dietary fiber and lignans (Hall *et al.,* 2006).

The nutritional composition of wheat egg-free cookies (as control) and high protein gluten-egg free analyzed chemical composition (Table 2). The analysis shows that moisture content cookies range 3.24-4.64%, this meets the national standards Indonesia cookies (SNI 01-2973 2011), i.e. water content cookies under 5%. It is the moisture content of the product is still new cookies that are under 5% (Okaka, 2009). Moisture content influence on shelf life, appearance, texture, and taste of the food. Low water levels are expected to increase the shelf life of cookies. The moisture content of cookies too low will produce the burnt cookies and the colors that are too dark, whereas if

moisture content is too high then the cookies generated have structures that are not too crisp and will trigger the flow of changes of flavor during storage (Manley, 2001).

The level of ash is a component that describes the levels of minerals in a given food. The higher value of ash content will be increasingly higher mineral content in it — the results of the analysis of ash levels of 3.45-4.51%. The levels of ash in the wheat cookies and gluten-egg free cookies were high enough, it is alleged to be caused by ash content of components constituting namely flaxseed (3.4%) (Ganorkar and Jain, 2013), the levels of *Coleus tuberosus* flour (4.4%), and all the constituents that each contain different levels of ash. A fairly high-fat content on cookies due to the contribution of margarine (17%) and fat-containing flaxseed about 41% (Ganorkar and Jain, 2013) and cheddar cheese. The fat content of cookies meets the Indonesia standard qualified quality pastries (cookies) according to SNI 01-2973-2011, i.e. a minimum fat content of 9.50%.

The protein content of high protein gluten-egg free cookies highest than wheat cookies. Protein levels on high protein gluten-egg free cookies are at 16 ± 0.10% – 17 ± 0.27%, wheat flour cookies was 15 ± 0.05%.Protein content on all-purpose and high protein gluten-egg free cookies qualified quality pastries (cookies) according to the standard national Indonesia SNI 01-29732011, i.e. minimum protein levels by 5%. High protein cookies contain high levels of protein most affected by one of the ingredients constituting, i.e. soy flour which has a protein content of 35-39.80% (Ciabotti *et al.,* 2016). Carbohydrate levels on high protein gluten-egg free cookies least than wheat cookies and all-purpose gluten-egg free cookies (Table 2). The difference in the levels of carbohydrates, because of the existence of a different content of protein, fat and total dietary fiber on cookies.

The difference in the amount of resistant starch of *M. arundinaceae* flour rich in RS3 levels gives an effect on gluten-egg free cookies. The levels of resistant starch on wheat cookies a lowest compared high protein gluten-free cookies eggs. Resistant starch has a functional role, not only lowers the amount of energy in food, improve digestive function, but also improve the quality of bread (Witczak *et al.,* 2016). RS can improve elasticity and porosity of bread (Tsatsaragkou *et al.,* 2014). Table 2 shows that the content of insoluble fiber more than soluble fiber. The difference in the content of dietary fibre on a gluten-egg free cookies and wheat flour cookies (as control) caused by ingredient of flour used which are soy four 6.70-10.70 (Ciabotti *et al.,* 2016), brown rice 2.25%, Maranta arundinaceae 7.46±0.12%, flaxseed 28% (Ganorkar and Jain, 2013).

3.2. Physical properties

Spread ratio is one of the characteristics that are important in determining the quality of cookies. The higher the spread ratio then it will be desired and show better quality. The value of the spread ratio with a substitution of RS will be decreased. Hardness is related to the force required to break the cookies (Özboy-Özbaş, 2010). High protein gluten-free cookies have a harder texture than wheat cookies (control). Table 3 shows that the spread ratio cookies high protein gluten-free cookies have spread the smallest ratio ($p < 0.05$). Spread ratio and texture on wheat flour cookies (control) are significantly different ($p < 0.05$) than three formulations of high protein gluten-free cookies. However, the spread ratio and texture of the three formulations of high protein gluten-free cookies were not different significantly. Spread ratio shows the capabilities of cookies to inflate (Olapade and Adeyemo, 2014). The higher spread ratio indicates that the ability to inflate wheat flour cookies better than gluten-egg free cookies. The expands the capabilities associated with high protein content in wheat egg-free flour cookies. The higher the protein in flour restricts the shape.

Texture results from fourth cookies contained in Table 3. The hardness of texture on high protein gluten-egg free cookies related to protein content. A high protein include requires more water to get right the dough cookies, and these cookies will have even higher hardness. The results of this study are in line with research that proves the cookie hardness increased with protein content from flour, especially above 10% (Fustier *et al.,* 2009). The harder texture of the cookies to the increased protein content and its interaction during development and baking (McWatters *et al.,* 2003). Protein content in cookies also affects the product's development power. This is because the proteins are subjected to denaturation so that the cookies are difficult to expand and become hard. Starch granules without proteins will be easily broken, and the amount of water entered in the starch granules will be more so that the development of starch becomes increased. Addition of margarine (fat) in the manufacture of cookies will change the texture, flavor, and flavor cookies. These fats can interact with starch granules and prevent hydration so that the increase in viscosity of the ingredients becomes low. The inhibiting mechanism is that the fat will form a layer on the outside of the starch granules and will also inhibit the penetration of water into the granules. A little water penetration will produce high gelatinization and will form cookies that are less inflated with a more dense texture so that there is a harder texture on three types of gluten-free cookies compared with cookies as a control caused by high protein and fat levels in gluten-free cookies.

3.3. Sensory properties

Sensory evaluation showed that wheat flour cookies (control) have the highest score than three types of high protein gluten-free cookies on the category color, aroma, flavor, texture (crispness) and overall acceptability ($P < 0.05$). Based on Table 4, wheat flour cookies obtain the highest score (7.90 ± 0.54) in overall acceptability compared to three types of cookies that use M. arundiaceae flour rich in RS3. The higher score a panelist has given, indicating that panelists increasingly like cookies. Product development of gluten-free cookies by using three formulations is done to get a new product that gets the best response from the panelist. The formulation I of Gluten-free cookies with 10% of Maranta Arundinaceae flour Rich in RS3, is the best response cookies from the panelist, it is indicated by a score of overalls acceptability of 7.58 ± 0.63. This score belongs to the category like very much. While the formulation II that used 12% of M. arundinaceae flour Rich in RS3 (7.23 ± 0.69) and formulation III that used 14% of Maranta Arundinaceae flour Rich in RS3 (7.14 ± 0.71) belong to the category like moderately. Although three types of gluten-free cookies are included in the categories like very much and like moderately, however, Table 4 shows that the addition of a percentage of the *M. arundinaceae* rich in RS3 impact on decreasing the level of acceptance of the panelists. The existence of a replacement of some parts of the wheat flour impact on decreasing by hedonic panelists evaluations scores against a product (Yusufu *et al.,* 2016).

Based on this research indicate that high protein gluten-egg free cookies on formulation I most preferred by the panelist (Table 5), which use *M. arundinaceae* flour rich in RS3 10% of the total ingredient of gluten-free flour. Results of this research show that the benefit of these cookies, besides gluten-free and egg-free, but also have other advantages, namely the content of resistant starch and dietary fiber. Gluten-free and eggs free cookies are enriched with resistant starch type 3 from *M. arundinaceae* could be developed into functional foods for people who are sensitive to gluten and eggs.

4. Conclusion

Types of cookies was selected for the high protein gluten-egg free cookies is a formula I with *M. arundaceae* flour rich in RS3 as much as 10% of total ingredient gluten-free flour. High protein gluten-egg cookies have characteristics most high protein, the smaller spread ratio and most hardness of texture than wheat flour cookies (as control). High protein gluten-egg free cookies contain resistant starch higher than wheat flour cookies (as control). The best high protein gluten-free cookies enriched with resistant starch Type 3 of *M. arundinaceae* (10%) Included in the category like very much. Based on the results of this study, the high protein gluten-free eriched with resistant starch Type 3 can be developed into a functional food primarily aimed to the people who are sensitive to gluten or egg allergies. Nevertheless, it can be attempted to increase overalls aceptability to the gluten-free cookies by lowering the number of percentages of *M. arundinaceae* flour Rich in RS3 used (less than 10%).

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

Authors would like to thanks to Directorate General of higher education for the research grants strategic competitive national with contract number 04/Penel./p. Stranas/UN 34.21/2017, 3rd April 2017.

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Table 1. Formulation of high protein gluten-free cookies with flaxseed as egg replacer

Ingredient	Wheat flour cookies as Control (g)	High protein Gluten free cookies F I (g)	High protein Gluten free cookies F II (g)	High protein Gluten free cookies F III (g)
Wheat flour	150	-		
Gluten-free flour high protein ingredient				
Soy flour		48	48	48
Corn starch		19	19	19
Maranta arundinaceae flour		19	19	19
Tapioca flour		13	10	7
Maranta arundinaceae rich RS3		15	18	20
Coleus tuberosus flour rich in RS3		1	1	1
Brown rice flour		35	35	35
Total Gluten free flour		**150**	**150**	**150**
Margarine	90	90	90	90
Egg	1			
Flaxseed	-	10	10	10
Corn syrup	15	15	15	15
Salt	2	2	2	2
Cheddar cheese	75	75	75	75
Chocolate powder	5	5	5	5
Water	-	45	45	45

Tabel 2. The nutritional properties of high protein gluten-free cookies with flaxseed as egg replacer

Parameter	Control	High protein gluten-free cookies with flaxseed as egg replacer		
		FI	FII	FIII
Moisture	3.88 ± 0.07[a]	4.64 ± 0.08[c]	4.60 ± 0.03[c]	3.69 ± 0.07[b]
Ash	3.45 ± 0.07[a]	4.93 ± 0.04[b]	4.69 ± 0.18[b]	4.71 ± 0.21[b]
Lipid	31.14 ± 0.13[a]	35.12 ± 0.10[c]	35.12 ± 0.03[c]	34.23 ± 0.60[b]
Protein	15.14 ± 0.05[a]	16.85 ± 0.10[c]	17.54 ± 0.27[d]	16.34 ± 0.10[b]
Carbohydrate	25.21 ± 0.11[d]	19.50 ± 0.19[a]	20.79 ± 0.06[b]	24.42 ± 0.08[c]
Soluble dietary fiber	0.54 ± 0.12[b]	0.54± 0.08[b]	0.59 ± 0.06[c]	0.37 ± 0.06[a]
Insoluble dietary fiber	20.56 ± 0.16[d]	18.40± 0.11[c]	16.66 ± 0.13[b]	16.16 ± 0.05[a]
Resistant starch	2.18 ± 0.18[a]	2.81 ± 0.17[b]	3.39 ± 0.07[c]	4.97 ± 0.08[d]

Values are the Mean±SD, different superscripts in the same row are significantly different ($p<0.05$)

Tabel 3. Physical characteristics wheat cookies, wheat flour cookies (WH-C), and high protein gluten-free cookies with flaxseed as egg replacer (HP-GFC)

Cookies type	Weight (gram)	Diameter (mm)	Height (mm)	Spread ratio	Texture
WH-C	1.51±0.02^{b}	33.99±0.13^{a}	3.51±0.03^{a}	9.69±0.09^{b}	12.24±0.25^{a}
HP-GFC FI	1.11±0.02a	31.47±0.20^{b}	3.77±0.09^{b}	8.34±0.23^{a}	13.67±0.22^{b}
HP-GFC FII	1.11±0.02^{a}	31.50±0.26^{b}	3.79±0.07^{b}	8.32±0.24^{a}	13.84±0.12^{b}
HP-GFC FIII	1.11±0.02^{a}	31.48±0.21^{b}	3.79±0.09^{b}	8.32±0.24^{a}	14.02±0.14^{b}

Values are the Mean±SD, different superscripts in the same row are significantly different ($p<0.05$)

Table 4. Sensory characteristics of wheat flour cookies (control), and high protein gluten-free cookies with flaxseed as egg replacer

Characteristic	Wheat cookies	High Protein gluten-free cookies		
		FI	FII	FIII
Aroma	8,01 ± 0,58^{c}	7.55 ± 0.67^{b}	7.23 ± 0.73^{a}	7.19 ± 0.68^{a}
Color	7,93 ± 0,67^{c}	7.40 ± 0.77^{b}	7.21 ± 0.74^{a}	7.06 ± 0.79^{a}
Taste	7,89 ± 0,50^{c}	7.56 ± 0.73^{b}	7.29 ± 0.78^{a}	7.29 ± 0.78^{a}
Crispiness	7,82 ± 0,55^{b}	7.71 ± 0.56^{c}	7.14 ± 0.65^{a}	6.98 ± 0.75^{a}
Overall aceptability	7,90 ± 0,54^{c}	7.58 ± 0.63^{b}	7.23 ± 0.69^{a}	7.14 ± 0.71^{a}

Values are the Mean±SD, different superscripts in the same row are significantly different ($p<0.05$)

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Authors	:	Nugraheni, M., Sutopo, Purwanti, S. and Handayani, T.H.W.

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FULL PAPER

Nutritional, physical and sensory properties of high protein gluten free cookies enriched with resistant starch type 3 of *Maranta arundinaceae* and flaxseed

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Article history:
Received: 4 April 2019
Received in revised form: 15 May 2019
Accepted: 16 May 2019
Available Online:

Keywords:
Cookies,
High protein,
Gluten and egg-free,
Maranta arundinaceae,
Flaxseed

DOI:

Abstract

This research was aimed to study on the nutritional, physical and sensory properties of the selected high protein gluten and egg-free cookies enriched resistant starch type 3 of *Maranta arundinaceae* with flaxseed as an egg replacer. The research method was done by making different cookies formulation based on the amount of *M. arundinaceae* flour enriched with resistant starch type 3 were developed. Cookies made with wheat flour was used as control. Cookies formulation based on the amount of *Maranta arundinaceae* flour rich in resistant starch type 3 and a control (wheat cookies). Proximate analysis, resistant starch and dietary fiber analysis were used to evaluate the nutritional properties of the cookie while the physical properties were evaluated based on the spread ratio and texture analysis. Physical properties with spread ratio calculation and texture analysis. The best cookies based on a hedonic test with 80 semi-trained panelists. The best high protein gluten and egg-free cookies were made with 10.5% resistant starch type 3 with the following: 16.84±0.10% protein content; 18.94±0.09% dietary fiber and 2.81±0.17% resistant starch levels. Physical properties: spread ratio 8.34±0.23; texture 13.67±0.22. Overall acceptance 7.56±0.63. Based on the results of this research, The developed high protein gluten free and egg free cookies will be beneficial for those who are sensitive to gluten and eggs.

1. Introduction

Cookies are associated with the source of energy and are a product that is ready to consume. Moreover, cookies can also be produced in high numbers with a short time, and it is easy to be widely distributed (Zucco *et al*., 2011). Indonesia has potential as a food source, i.e. tubers, legumes, cereals which can be used as a constituent of the development of gluten-free flour for making cookies. According to SNI 01-2973-1992, cookies are one of the types of biscuits made from soft dough, containing high fat, relatively crisp when broken and densely textured. According to Mamat and Hill (2014), fat in cookies serves as shortening which affects the texture, flavor, tenderness, and mouthfeel. The essential ingredients of making cookies consist of flour with protein, fat, sugar, and eggs.

The development of gluten-free cookies is currently required in line with the growing demand for functional foods that can minimize the occurrence of allergies to constituents such as gluten and eggs. Gluten-free food products also have benefits to reduce the risk and create a type 1 diabetes mellitus (Filbert and Sein, 2013). Gluten contained in wheat flour is usually used for the making of cookies can be an issue for people who are allergic to gluten (Boettcher and Crowe, 2013). Making cookies that use eggs, can also cause allergies in sensitive people because the egg is one of the allergens (Barros and Cosme, 2013) so that It is necessary to use egg replacer such as flaxseed (Uhlman and Schumacher, 2014). The use of food as a source of carbohydrates can be done for patients with diabetes mellitus, for example, tubers, legumes, and cereals, but the need to attempt to do the modifications in the processing to increase the levels of resistant starch (Alcazar-alay and Meireles, 2015). Resistant starch can provide a positive impact on the management of the lipid and glucose profile in diabetics mellitus and improve insulin sensitivity so that it can be developed for the management of diabetes mellitus type 2 (Robertson *et al.,* 2005). Resistant starch can be produced by autoclaving-cooling could increase levels of RS3 on carbohydrate materials (Lilia-Baby *et al.,* 2016).

High protein gluten and egg-free cookies enriched

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eISSN: 2550-2166

with resistant starch type 3 of *M. arundinaceae* is a new product that has a composition of different constituent materials with wheat cookies that are currently sold to consumers. The difference in the composition of the composition material can affect the characteristics of the cookies, not only nutrients, physical, but also sensory properties. The development efforts of high protein gluten-free cookies enriched with resistant starch type 3 into functional food directed at the commercialization of the product, must be supported with clear information related to nutrition, physical and sensory properties. So, it is necessary to further research to find out the formulation impact of high protein gluten-free cookies enriched with resistant starch type 3 to the characteristics of the cookies.

This study is aimed to determine the characteristics of nutritional, physical and sensory properties of the high protein gluten and egg-free cookies enriched resistant starch type 3 of *M. arundinaceae* with flaxseed as an egg replacer.

2. Materials and methods

2.1 Materials

M. arundinacea flour, brown rice flour, and soy flour obtained from local farmers in Clereng Kulon Progo, Yogyakarta, Indonesia. Tapioca flour, cornstarch, flaxseed obtained from commercial market in Yogyakarta, Indonesia. *M. arundinaceae* and *Coleus tuberosus* flour rich in RS3 was produced by 3 -cycle autoclaving-cooling (Mutiara *et al.,* 2017).

2.2 Formulation of cookies

The cookies recipe refer to a reference cookies recipe (Gisslen, 2012) with little modifications, by replacing the eggs with flaxseed, and wheat four change with high protein gluten-free flour. High protein gluten and egg-free cookies rich in *M. arundinaceae* rich in RS3 made three formulations (FI, FII, and FIII). This formulation was based on the differences in the percentage of the amount of *M. arundinaceae* flour abundant in RS3. FI use 10%, F2 use 12%, using FIII using 14% (Table 1). The making of flaxseed as a eggs replacer done with flaxseed gel making. Some 10 g flaxseed added 45 mL water, stirred and allowed in the refrigerator for 15 mins. Constituents cookies, i.e. margarine, sugar, stir until creamy, then mix with the flaxseed gel to evenly. Then added high protein gluten-free flour, cocoa, and cheese. Cookies formed and baked with the temperature of the top 120^{o}C and bottom 110^{o}C during 40 mins.

2.3 Chemical characteristics

Chemical analysis of the content of moisture, ash, fat, protein and dietary fiber using AOAC method (2005). Carbohydrate content determined by difference. Resistant starch levels established by the methods developed by Englyst *et al.* (1992).

2.4 Physical characteristics

Cookies are taken as a random, weighted using digital scales. Thickness (height) and the diameter was measured using vernier caliper (Trickle brand, Shanghai China). Measurement of the width and diameter of the cookies was done by taking three samples. Spread ratio is calculated using the formula: diameter cookies divided thick (height) cookies (Zoulias *et al.,* 2000). Physical

Table 1. Formulation of high protein gluten-free cookies with flaxseed

Ingredient	Wheat flour cookies	High protein gluten and	High protein gluten and	High protein gluten and
Wheat flour	150	-		
Gluten-free flour high protein ingredient				
Soy flour		48	48	48
Corn starch		19	19	19
M. arundinaceae flour		19	19	19
Tapioca flour		13	10	7
M. arundinaceae rich RS3		15	18	20
C. tuberosus flour rich in RS3		1	1	1
Brown rice flour		35	35	35
Total Gluten free flour		**150**	**150**	**150**
Margarine	90	90	90	90
Egg	1			
Flaxseed	-	10	10	10
Corn syrup	15	15	15	15
Salt	2	2	2	2
Cheddar cheese	75	75	75	75
Chocolate powder	5	5	5	5
Water	-	45	45	45

characteristics measured using cookies Liyod universal testing machine type 1000 S within 24 hrs after the baking process.

2.5 Sensory evaluation

The sensory evaluation carried out by 80 people semi-trained panelists (30 men, 50 women) of students of the Culinary Art Education Department, Yogyakarta State University. Evaluation based on the 9-point hedonic scale method: 1 (dislike extremely) and 9 (like extremely) and Evaluation of the cookies was done 24 hrs after baking process cookies. Sensory tests carried out on four types of cookies.

2.6 Statistical analysis

Data were analysed with SPSS version 11.0 (Illinois, USA) using one-way analysis of variance (ANOVA). Significant differences were tested using LSD. Three replications were used for chemical and physical analyses, sensory evaluation with 80 semi-trained panelist, and statistical significance was set at $p<0.05$.

3. Results and discussion

3.1. Nutritional analysis of wheat cookies (control) and high protein gluten-free cookies

As many as four kinds of cookies made in this study, i.e., control cookies made from 100% wheat flour and egg-free, and three types of high protein gluten and egg-free cookies. The role of the egg was replaced by flaxseed. Flaxseed is capable of forming a gel when mixed with water, the consistency of which is constructed like the consistency of egg (Uhlman and Schumacher, 2014) and have the functional compounds, such as α-linolenic acid (ALA), dietary fiber and lignans (Hall *et al.,* 2006).

The nutritional composition of wheat and egg-free cookies (as control) and high protein gluten and egg-free analyzed chemical composition (Table 2). The analysis shows that moisture content cookies range 3.24 - 4.64%, this meets the national standards Indonesia cookies (SNI 01-2973 2011), i.e. water content cookies under 5%. It is the moisture content of the product is still new cookies that are under 5% (Okaka, 2009). Moisture content influence on shelf life, appearance, texture, and taste of the food. Low water levels are expected to increase the shelf life of cookies. The moisture content of cookies too low will produce the burnt cookies and the colors that are too dark, whereas if the moisture content is too high then the cookies generated have structures that are not too crisp and will trigger the flow of changes of flavor during storage (Manley, 2001).

The level of ash is a component that describes the levels of minerals in a given food. The higher value of ash content will be increasingly higher mineral content in it - the results of the analysis of ash levels of 3.45 - 4.51%. The levels of ash in the wheat cookies and gluten -egg free cookies were high enough, it is alleged to be caused by ash content of components constituting namely flaxseed (3.4%) (Ganorkar and Jain, 2013), the levels of *Coleus tuberosus* flour (4.4%), and all the constituents that each contain different levels of ash. A fairly high-fat content on cookies due to the contribution of margarine (17%) and fat-containing flaxseed about 41% (Ganorkar and Jain, 2013) and cheddar cheese. The fat content of cookies meets the Indonesia standard qualified quality pastries (cookies) according to SNI 01-2973-2011, i.e. a minimum fat content of 9.50%.

The protein content of high protein gluten and egg-free cookies highest than wheat cookies. Protein levels on high protein gluten-egg free cookies are at 16±0.10% – 17±0.27%, wheat flour cookies was 15±0.05%. Protein content on all-purpose and high protein gluten-egg free cookies qualified quality pastries (cookies) according to the standard national Indonesia SNI 01-29732011, i.e. minimum protein levels by 5%. High protein cookies contain high levels of protein most affected by one of the ingredients constituting, i.e. soy flour which has a protein content of 35 - 39.80% (Ciabotti *et al.,* 2016). Carbohydrate levels on high protein gluten-egg free

Table 2. The nutritional properties of high protein gluten-free cookies with flaxseed

Parameter	Control	High protein gluten-free cookies with flaxseed		
		FI	FII	FIII
Moisture	3.88±0.07^{a}	4.64±0.08^{c}	4.60±0.03^{c}	3.69±0.07^{b}
Ash	3.45±0.07^{a}	4.93±0.04^{b}	4.69±0.18^{b}	4.71±0.21^{b}
Lipid	31.14±0.13^{a}	35.12±0.10^{c}	35.12±0.03^{c}	34.23±0.60^{b}
Protein	15.14±0.05^{a}	16.85±0.10^{c}	17.54±0.27^{d}	16.34±0.10^{b}
Carbohydrate	25.21±0.11^{d}	19.50±0.19^{a}	20.79±0.06^{b}	24.42±0.08^{c}
Soluble dietary fiber	0.54±0.12^{b}	0.54±0.08^{b}	0.59±0.06^{c}	0.37±0.06^{a}
Insoluble dietary fiber	20.56±0.16^{d}	18.40±0.11^{c}	16.66±0.13^{b}	16.16±0.05^{a}
Resistant starch	2.18±0.18^{a}	2.81±0.17^{b}	3.39±0.07^{c}	4.97±0.08^{d}

Values are mean±SD. Different alphabet superscripts in the same row are significantly different ($p<0.05$)

cookies least than wheat cookies and all-purpose gluten-egg free cookies (Table 2). The difference in the levels of carbohydrates, because of the existence of different content of protein, fat and total dietary fiber on cookies.

The difference in the amount of resistant starch of *M. arundinaceae* flour rich in RS3 levels gives an effect on gluten and egg-free cookies. The levels of resistant starch on wheat cookies a lowest compared high protein gluten-egg free cookies. Resistant starch has a functional role, not only lowers the amount of energy in food, improve digestive function, but also improve the quality of bread (Witczak *et al.,* 2016). RS can improve elasticity and porosity of bread (Tsatsaragkou *et al.,* 2014). Table 2 shows that the content of insoluble fiber more than soluble fiber. The difference in the content of dietary fibre on a gluten-egg free cookies and wheat flour cookies (as control) caused by ingredient of flour used which are soy four 6.70 - 10.70 (Ciabotti *et al.,* 2016), brown rice 2.25%, Maranta arundinaceae 7.46±0.12%, flaxseed 28% (Ganorkar and Jain, 2013).

3.2 Physical properties

Spread ratio is one of the characteristics that are important in determining the quality of cookies. The higher the spread ratio then it will be desired and show better quality. The value of the spread ratio with a substitution of RS will be decreased. Hardness is related to the force required to break the cookies (Özboy-Özbaş *et al.,* 2010). High protein gluten and egg-free cookies have a harder texture than wheat cookies (control). Table 3 shows that the spread ratio cookies high protein gluten-free cookies have spread the smallest ratio ($p<0.05$). Spread ratio and texture on wheat flour cookies (control) are significantly different ($p <0.05$) than three formulations of high protein gluten-free cookies. However, the spread ratio and texture of the three formulations of high protein gluten-free cookies were not different significantly. Spread ratio shows the capabilities of cookies to inflate (Olapade and Adeyemo, 2014). The higher spread ratio indicates that the ability to inflate wheat flour cookies better than gluten-egg free cookies. The expands the capabilities associated with high protein content in wheat egg-free flour cookies. The higher the protein in flour restricts the shape.

Texture results from fourth cookies contained in Table 3. The hardness of texture on high protein gluten-egg free cookies related to protein content. A high protein include requires more water to get right the dough cookies, and these cookies will have even higher hardness. The results of this study are in line with research that proves the cookie hardness increased with protein content from flour, especially above 10% (Fustier *et al.,* 2009). The harder texture of the cookies to the increased protein content and its interaction during development and baking (McWatters *et al.,* 2003). Protein content in cookies also affects the product's development power. This is because the proteins are subjected to denaturation so that the cookies are difficult to expand and become hard. Starch granules without proteins will be easily broken, and the amount of water entered in the starch granules will be more so that the development of starch becomes increased. Addition of margarine (fat) in the manufacture of cookies will change the texture, flavor, and flavor cookies. These fats can interact with starch granules and prevent hydration so that the increase in viscosity of the ingredients becomes low. The inhibiting mechanism is that the fat will form a layer on the outside of the starch granules and will also inhibit the penetration of water into the granules. A little water penetration will produce high gelatinization and will form cookies that are less inflated with a denser texture so that there is a harder texture on three types of gluten-free cookies compared with cookies as a control caused by high protein and fat levels in gluten-free cookies.

3.3 Sensory properties

Sensory evaluation showed that wheat flour cookies (control) have the highest score than three types of high protein gluten and egg-free cookies on the category color, aroma, flavor, texture (crispness) and overall acceptability ($P<0.05$). Based on Table 4, wheat flour cookies obtain the highest score (7.90±0.54) in overall acceptability compared to three types of cookies that use M. arundiaceae flour rich in RS3. The higher score a panelist has given, indicating that panelists increasingly like cookies. Product development of gluten-free cookies by using three formulations is done to get a new product that gets the best response from the panelist. The formulation I of Gluten-free cookies with 10% of *M. arundinaceae* flour Rich in RS3, is the best response cookies from the panelist, it is indicated by a score of overalls acceptability of 7.58±0.63. This score belongs to the category like very much. While the formulation II that used 12% of M. arundinaceae flour Rich in RS3 (7.23±0.69) and formulation III that used 14% of *M. arundinaceae* flour Rich in RS3 (7.14±0.71) belong to the category like moderately. Although three types of gluten-free cookies are included in the categories like very much and like moderately, however, Table 4 shows that the addition of a percentage of the *M. arundinaceae* rich in RS3 impact on decreasing the level of acceptance of the panelists. The existence of a replacement of some parts of the wheat flour impact on decreasing by hedonic panelists evaluations scores against a product (Yusufu *et al.,* 2016).

Table 3. Physical characteristics wheat cookies, wheat flour cookies (WH-C), and high protein gluten and egg-free cookies with flaxseed (HP-GFC)

Cookies type	Weight (gram)	Diameter (mm)	Height (mm)	Spread ratio	Texture
WH-C	1.51±0.02^{b}	33.99±0.13^{a}	3.51±0.03^{a}	9.69±0.09^{b}	12.24±0.25^{a}
HP-GFC FI	1.11±0.02a	31.47±0.20^{b}	3.77±0.09^{b}	8.34±0.23^{a}	13.67±0.22^{b}
HP-GFC FII	1.11±0.02^{a}	31.50±0.26^{b}	3.79±0.07^{b}	8.32±0.24^{a}	13.84±0.12^{b}
HP-GFC FIII	1.11±0.02^{a}	31.48±0.21^{b}	3.79±0.09^{b}	8.32±0.24^{a}	14.02±0.14^{b}

Values are mean±SD. Different alphabet superscripts in the same row are significantly different ($p<0.05$)

Table 4. Sensory characteristics of wheat flour cookies (control), and high protein gluten and egg-free cookies with flaxseed

Characteristic	Wheat cookies	High Protein gluten and egg-free cookies		
		FI	FII	FIII
Aroma	8.01±0.58^{c}	7.55±0.67^{b}	7.23±0.73^{a}	7.19±0.68^{a}
Color	7.93±0.67^{c}	7.40±0.77^{b}	7.21±0.74^{a}	7.06±0.79^{a}
Taste	7.89±0.50^{c}	7.56±0.73^{b}	7.29±0.78^{a}	7.29±0.78^{a}
Crispiness	7.82±0.55^{b}	7.71±0.56^{c}	7.14±0.65^{a}	6.98±0.75^{a}
Overall Aceptability	7.90±0,54^{c}	7.58±0.63^{b}	7.23±0.69^{a}	7.14±0.71^{a}

Values are mean±SD. Different alphabet superscripts in the same row are significantly different ($p<0.05$)

Table 5. Formulation of the most prefered of the high protein gluten and egg-free cookies with flaxseed by panelist

Ingredient	High protein gluten and egg-free cookies F I (g)
Wheat flour	-
Gluten-free flour high protein ingredient	
Soy flour	48
Corn starch	19
Maranta arundinaceae flour	19
Tapioca flour	13
Maranta arundinaceae rich RS3	15
Coleus tuberosus flour rich in RS3	1
Brown rice flour	35
Total Gluten free flour	**150**
Margarine	90
Egg	
Flaxseed	10
Corn syrup	15
Salt	2
Cheddar cheese	75
Chocolate powder	5
Water	45

Based on this research indicate that high protein gluten-egg free cookies on formulation I most preferred by the panelist (Table 5), which use *M. arundinaceae* flour rich in RS3 10% of the total ingredient of gluten-free flour. Results of this research show that the benefit of these cookies, besides gluten and egg-free, but also have other advantages, namely the content of resistant starch and dietary fiber. Gluten and egg-free cookies are enriched with resistant starch type 3 from *M. arundinaceae* could be developed into functional foods for people who are sensitive to gluten and eggs.

4. Conclusion

The most accepted formulation of cookies for the high protein gluten-egg free cookies was the formula I with *M. arundaceae* flour rich in RS3 as much as 10% of total ingredient gluten-free flour. The high protein gluten -egg cookies have the following characteristics: highest protein content, smaller spread ratio and higher degree of hardness than wheat flour cookies (as control). Based on the results of this study, the high protein gluten-free enriched with resistant starch Type 3 can be developed into a functional food primarily aimed at the people who are sensitive to gluten or egg allergies. Nevertheless, future studies are expected to increase the overall acceptability of the gluten and egg-free cookies by lowering the number of percentages of *M. arundinaceae* flour Rich in RS3 used (less than 10%).

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

Authors would like to thanks to Directorate General of higher education for the research grants strategic competitive national with contract number 04/Penel./p. Stranas/UN 34.21/2017, 3rd April 2017.

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eISSN: 2550-2166

Food Research 3 (6) : 658 - 663 (December 2019)
Journal homepage: http://www.myfoodresearch.com

FOOD RESEARCH

FULL PAPER

Nutritional, physical and sensory properties of high protein gluten and egg-free cookies made with resistant starch type 3 *Maranta arundinaceae* flour and flaxseed

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Article history:
Received: 4 April 2019
Received in revised form: 15 May 2019
Accepted: 16 May 2019
Available Online: 24 May 2019

Keywords:
Cookies,
High protein,
Gluten and egg-free,
Maranta arundinaceae,
Flaxseed

DOI:
https://doi.org/10.26656/fr.2017.3(6).145

Abstract

This research was aimed to study on the nutritional, physical and sensory properties of the developed high protein gluten and egg-free cookies made with resistant starch type 3 (RS3) *Maranta arundinaceae* flour and flaxseed as egg replacer. The research method was done by examining the different cookies formulations based on the amount of RS3 *M. arundinaceae* flour. Cookies made with wheat flour was used as control. Proximate analysis, resistant starch and dietary fiber analysis were used to evaluate the nutritional properties of the developed cookies while the physical properties were evaluated based on the spread ratio and texture analysis. The outcome of this research had proved that cookies made with 10% RS3 *M. arundinaceae* flour was highly accepted with an overall acceptance score of 7.56±0.63 from the sensory evaluation. The cookies also had the following nutritional properties: 16.84±0.10% protein content; 18.94±0.09% dietary fiber; and 2.81±0.17% resistant starch levels along with the following physical proerties: 8.34±0.23 spread ratio and 13.67±0.22 texture. The developed cookies will be beneficial to those who are sensitive to gluten and/or eggs.

1. Introduction

Cookies are associated as the source of energy and are a product that is ready to be consumed. Moreover, cookies can also be produced in high numbers with a short time, and it is easy to be widely distributed (Zucco *et al*., 2011). Indonesia has the abundance of food sources, i.e. tubers, legumes, cereals which can be used as a constituent of the development of gluten-free flour for making cookies. According to SNI 01-2973-1992, cookies are one of the types of biscuits made from soft dough, containing high fat, relatively crisp when broken and densely textured. According to Mamat and Hill (2014), fat in cookies serves as shortening which affects the texture, flavor, tenderness, and mouthfeel. The essential ingredients of making cookies consist of flour with protein, fat, sugar, and eggs.

The development of gluten-free cookies is currently required in line with the growing demand for functional foods that can minimize the occurrence of allergies to constituents such as gluten and eggs (Barros and Cosme, 2013). Gluten-free food products also have benefits to reduce the risk of type 1 diabetes mellitus (Filbert and Sein, 2013). Wheat flour which is high in gluten is commercially used for the production of cookies and this can be an issue for people who are allergic to gluten (Boettcher and Crowe, 2013).

The use of different food such as tubers, legumes and cereals as a source of carbohydrate is possible for patients with diabetes mellitus. However, there is a need to attempt the modifications in the processing to increase the levels of resistant starch (Alcazar-alay and Meireles, 2015). This is because, resistant starch can provide a positive impact on the management of the lipid and glucose profile in diabetics mellitus and improve insulin sensitivity for a better management of diabetes mellitus type 2 (Robertson *et al.,* 2005). Resistant starch can be produced by the autoclaving-cooling process which increased the levels of RS3 in carbohydrate materials (Lilia-Baby *et al.,* 2016).

High protein gluten and egg-free cookies made with RS3 of *M. arundinaceae* flour is a new product that has a composition of different constituent materials from wheat flour made cookies that are currently sold to consumers. The difference in the composition of material may affect the characteristics of the cookies, in terms of the nutrients, physical properties, but also sensory

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eISSN: 2550-2166

properties. The development efforts of commercialization of high protein gluten-free cookies enriched with RS3 into functional food must be supported with clear information of the nutrition, physical and sensory properties. So, it is necessary to research on the formulation impact of the developed RS3 high protein gluten-free cookies.

This study is aimed to determine the characteristics of nutritional, physical and sensory properties of the high protein gluten and egg-free cookies made with RS3 *M. arundinaceae* flour and flaxseed as an egg replacer.

2. Materials and methods

2.1 Materials

M. arundinaceae flour, brown rice flour, and soy flour obtained from local farmers in Clereng Kulon Progo, Yogyakarta, Indonesia. Tapioca flour, cornstarch, flaxseed obtained from commercial market in Yogyakarta, Indonesia. *M. arundinaceae* and *Coleus tuberosus* flour rich in RS3 was produced by 3-cycle autoclaving-cooling process (Mutiara *et al.,* 2017).

2.2 Formulation of cookies

The cookies recipe was referred to the reference cookies recipe by Gisslen (2012) with little modifications (Table 1). Three formulations (FI, FII, and FIII) were concocted based on the different precentage of RS3 *M. arundinaceae* flour where FI used 10%; FII used 12%; FIII used 14%.

Eggs were replaced with flaxseed. Some 10 g flaxseed was added 45 mL water and stirred. It was allowed to sit in the refrigerator for 15 mins to complete the gel making process. The other constituents of the cookies were stirred and mixed evenly with the flaxseed gel. Then, the high protein gluten-free flour (composition can be referred in Table 1) was folded in with cocoa and cheese. Cookies were shaped and baked in the top bottom heating oven (Top: 120^{o}C; Bottom: 110^{o}C) for 40 mins.

2.3 Nutritional analysis

Proximate analysis, comprising of the moisture content, ash content, fat, protein and dietary fiber, were performed following AOAC methods (2005). The carbohydrate content was determined by difference. The resistant starch levels was determined by the methods of Englyst *et al.* (1992).

2.4 Physical properties

Cookies are taken at random and weighed using digital scales. The thickness (height) and the diameter of the cookies in triplicates was measured using a vernier caliper (Trickle brand, Shanghai China). Spread ratio was calculated dividing the diameter of the cookies with the thickness of the cookies (height) (Zoulias *et al.,* 2000). The texture of the cookies was measured with Liyod universal testing machine type 1000 S within 24 hrs after the baking.

2.5 Sensory evaluation

The sensory evaluation was carried out by eighty people semi-trained panelists (30 men, 50 women) of students from the Culinary Art Education Department,

Table 1. Formulations of developed high protein gluten and egg-free cookies

Ingredient	Wheat flour cookies as Control (g)	High protein gluten and egg-free cookies FI (g)	High protein gluten and egg-free cookies FII (g)	High protein gluten and egg-free cookies FIII (g)
Wheat flour	150	-	-	-
High protein gluten-free flour composition				
Soy flour		48	48	48
Corn starch		19	19	19
M. arundinaceae flour		19	19	19
Tapioca flour		13	10	7
RS3 *M. arundinaceae* flour		15	18	20
RS3 *C. tuberosus* flour		1	1	1
Brown rice flour		35	35	35
Total amount of flour	**150**	**150**	**150**	**150**
Other ingredients				
Margarine	90	90	90	90
Egg	1			
Flaxseed	-	10	10	10
Corn syrup	15	15	15	15
Salt	2	2	2	2
Cheddar cheese	75	75	75	75
Chocolate powder	5	5	5	5
Water	-	45	45	45

eISSN: 2550-2166

Yogyakarta State University. The evaluation was based on a 9-point hedonic scale: 1 (dislike extremely) and 9 (like extremely). The sensory evaluation was carried out on the four types of cookies baked after 24 hrs.

2.6 Statistical analysis

Data were analyzed with SPSS version 11.0 (Illinois, USA) using one-way analysis of variance (ANOVA) and LSD for significant difference at $p<0.05$.

3. Results and discussion

3.1. Nutritional analysis

The nutritional composition of the four kind cookies made in this study, i.e., control cookies made from 100% wheat flour and three different formulations of high protein gluten and egg-free cookies are tabulated in Table 2. The role of the egg was replaced by flaxseed. Flaxseed is capable of forming a gel when mixed with water, the consistency of which is constructed like the consistency of egg (Uhlman and Schumacher, 2014) and have the functional compounds, such as α-linolenic acid (ALA), dietary fiber and lignans (Hall *et al.,* 2006).

The analysis showed that moisture content of the cookies ranged from 3.24 - 4.64%, following the national standards Indonesia cookies (SNI 01-2973 2011) where the moisture content of freshly produced cookies should be under 5% (Okaka, 2019). The moisture content influences the shelf life, appearance, texture, and taste of the food. Low water levels are expected to increase the shelf life of cookies. On the contrary, moisture content of cookies that are too low will produce burnt cookies. Whereas, if the moisture content is too high then the cookies produced are not crispy and will trigger the changes of flavor during storage (Manley, 2001).

The level of ash is a component that describes the levels of minerals in a given food. The higher value of ash content indicates the higher mineral content. The cookies had the ash content of 3.45 - 4.93%. The levels of ash in the control cookies and high protein gluten-egg free cookies were highly alleged to be caused by components such as the flaxseed (3.4%) (Ganorkar and Jain, 2013) and *C. tuberosus* flour (4.4%) with the remaining constituents contributing to the different levels of ash. The fairly high-fat content in cookies was due to the margarine (17%), the fat-containing flaxseed (41%) (Ganorkar and Jain, 2013) and the cheddar cheese used as the ingredients. Nevertheless, the fat content of cookies met the Indonesia standard qualified quality pastries (cookies) according to SNI 01-2973-2011 where the minimum fat content of 9.50%.

The protein content of high protein gluten and egg-free cookies was the highest (16±0.10 - 17±0.27%) when compared with the control cookies (15±0.05%). The protein content on the all purpose and high protein gluten -egg free cookies qualified the quality pastries (cookies) according to the standard national Indonesia SNI 01-29732011 where the minimum protein levels by 5%. According to Ciabotti et al. (2016), soy flour has a protein content of 35 - 39.80% which contributed to the high protein content. The carbohydrate levels of high protein gluten and egg-free cookies was the least than the control cookies (Table 2). The difference in the levels of carbohydrates was due to the existence of different content of protein, fat and total dietary fiber of the cookies.

The difference in the amount of RS3 *M. arundinaceae* flour gave an effect on the developed cookies. The levels of resistant starch in control cookies was the lowest compared to high protein gluten-egg free cookies. Resistant starch has a functional role whereby it not only lowers the amount of energy in food and improves the digestive function, but also improve the quality of bread (Witczak *et al.,* 2016). Resistant starch can also improve the elasticity and porosity of bread (Tsatsaragkou *et al.,* 2014). The content of insoluble fiber of the high protein gluten and egg-free cookies was more than soluble fiber (Table 2). The difference in the dietary fiber content could be due to the different dietary fiber of different flours used in the high protein gluten-free flour composition. Soy flour contained 6.70 - 10.70% of dietary fiber (Ciabotti *et al.,* 2016). Brown

Table 2. The nutritional properties of high protein gluten and egg-free cookies with flaxseed

Parameter	Control	High protein gluten-free cookies with flaxseed		
		FI	FII	FIII
Moisture	3.88±0.07[a]	4.64±0.08[c]	4.60±0.03[c]	3.69±0.07[b]
Ash	3.45±0.07[a]	4.93±0.04[b]	4.69±0.18[b]	4.71±0.21[b]
Lipid	31.14±0.13[a]	35.12±0.10[c]	35.12±0.03[c]	34.23±0.60[b]
Protein	15.14±0.05[a]	16.85±0.10[c]	17.54±0.27[d]	16.34±0.10[b]
Carbohydrate	25.21±0.11[d]	19.50±0.19[a]	20.79±0.06[b]	24.42±0.08[c]
Soluble dietary fiber	0.54±0.12[b]	0.54±0.08[b]	0.59±0.06[c]	0.37±0.06[a]
Insoluble dietary fiber	20.56±0.16[d]	18.40±0.11[c]	16.66±0.13[b]	16.16±0.05[a]
Resistant starch	2.18±0.18[a]	2.81±0.17[b]	3.39±0.07[c]	4.97±0.08[d]

Values are mean±SD. Different alphabet superscripts in the same row are significantly different ($p<0.05$)

rice flour contained 2.25% dietary fiber. *M. arundinaceae* flour contained 7.46±0.12% dietary fiber. In addition, flaxseed was also reported to contain 28% dietary fiber (Ganorkar and Jain, 2013).

3.2 Physical properties

Spread ratio is one of the characteristics that are important in determining the quality of cookies. The higher the spread ratio, the higher the desirable qualities. The value of the spread ratio decreased with a substitution of resistant starch. Hardness is related to the force required to break the cookies (Özboy-Özbaş *et al.,* 2010). High protein gluten and egg-free cookies have a harder texture than the control cookies. Table 3 shows that the spread ratio cookies high protein gluten-free cookies have the smallest spread ratio ($p<0.05$) and significantly different from the control cookies. No significant difference was observed among the different formulations of high protein gluten and egg-free cookies. Spread ratio shows the capabilities of cookies to inflate (Olapade and Adeyemo, 2014). A higher spread ratio indicates the ability to inflate. Due to the lower spread ratio of high protein gluten and egg-free cookies, the shape of the cookies were restricted.

Texture results of the cookies are shown in Table 3. The hardness of the high protein gluten-egg free cookies can be related to protein content which requires more water to get right dough cookies. The results of this study were in line with the research that proves the cookie hardness increased with protein content from flour, especially above 10% (Fustier *et al.,* 2009). Due to the higher protein content, the increased of its interaction occurs during development and baking (McWatters *et al.,* 2003). The protein content in cookies also affects the product's development power. This is because the proteins are subjected to denaturation and thus, cookies become difficult to expand and turn hard. Starch granules without proteins will be easily broken, and the amount of water entered in the starch granules will be more so that the development of starch increases. The addition of margarine (fat) in the production of cookies will change the texture and flavor of the cookies. These fats can interact with starch granules and prevent hydration to increase the viscosity of the ingredients. The inhibiting mechanism is that the fat will form a layer on the outside of the starch granules preventing the penetration of water into the granules. A little water penetration will produce high gelatinization and will form cookies that are less inflated with denser texture which makes up the harder texture of the high protein gluten and egg-free cookies compared to the control cookies.

3.3 Sensory properties

Sensory evaluation showed that control cookies have the highest score than the high protein gluten and egg-free cookies in terms of color, aroma, flavor, texture (crispness) and overall acceptability ($p<0.05$). Based on Table 4, control cookies obtain the highest score (7.90±0.54) in overall acceptability compared to the cookies made with RS3 *M. arundinaceae* flour. Cookies made with 10% RS3 *M. arundinaceae* flour had the best overall acceptability of 7.58±0.63 among the cookies made with the high protein flour composition. While the cookies made with 12% of *M. arundinaceae* flour was favoured next and the least favoured was cookies made with 14% *M. arundinaceae* flour with scores of 7.23±0.69 and 7.14±0.71 respectively. It can be depicted that the increasing amount of RS3 *M. arundinaceae* flour decreases its level of acceptance and that the replacement of the wheat flour had impactly decreased the evaluation of a product by the hedonic panelist. (Yusufu *et al.,* 2016).

Based on this research, it can be indicated that the high protein gluten and egg-free cookies made with 10% of RS3 *M. arundinaceae* flour is most preferred (Table 5). The developed high protein gluten and egg-free cookies will be health-benefitting particularly to those who are allergic to gluten and/or eggs and also contain resistant starch and high in dietary fiber.

4. Conclusion

High protein gluten and egg-free cookies made with 10% RS3 *M. arundinaceae* flour was the most accepted cookies. Despite having smaller spread ratio and higher degree of hardness than wheat flour made cookies due to the high protein content, the cookies can be developed in a functional food for people sensitive to gluten and/or eggs. It is recommended that future studies such as lowering the amount of RS3 *M. arundinaceae* flour used and substituting other ingredients, should be conducted to further improve the overall acceptability of the cookies.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

Authors would like to thanks to Directorate General of higher education for the research grants strategic competitive national with contract number 04/Penel./p. Stranas/UN 34.21/2017, 3rd April 2017.

Table 3. Physical properties of wheat flour made cookies (WH-C) and high protein gluten and egg-free cookies with flaxseed (HP-GFC) of different formulations

Cookies type	Weight (g)	Diameter (mm)	Height (mm)	Spread ratio	Texture
WH-C	1.51±0.02[b]	33.99±0.13[a]	3.51±0.03[a]	9.69±0.09[b]	12.24±0.25[a]
HP-GFC FI	1.11±0.02a	31.47±0.20[b]	3.77±0.09[b]	8.34±0.23[a]	13.67±0.22[b]
HP-GFC FII	1.11±0.02[a]	31.50±0.26[b]	3.79±0.07[b]	8.32±0.24[a]	13.84±0.12[b]
HP-GFC FIII	1.11±0.02[a]	31.48±0.21[b]	3.79±0.09[b]	8.32±0.24[a]	14.02±0.14[b]

Values are mean±SD. Different alphabet superscripts in the same row are significantly different ($p<0.05$)

Table 4. Sensory evaluation of wheat flour made cookies (control) and high protein gluten and egg-free cookies with flaxseed of different formulations

Characteristic	Wheat cookies	High Protein gluten and egg-free cookies		
		FI	FII	FIII
Aroma	8.01±0.58[c]	7.55±0.67[b]	7.23±0.73[a]	7.19±0.68[a]
Color	7.93±0.67[c]	7.40±0.77[b]	7.21±0.74[a]	7.06±0.79[a]
Taste	7.89±0.50[c]	7.56±0.73[b]	7.29±0.78[a]	7.29±0.78[a]
Crispiness	7.82±0.55[b]	7.71±0.56[c]	7.14±0.65[a]	6.98±0.75[a]
Overall aceptability	7.90±0.54[c]	7.58±0.63[b]	7.23±0.69[a]	7.14±0.71[a]

Values are mean±SD. Different alphabet superscripts in the same row are significantly different ($p<0.05$)

Table 5. Formulation of the most prefered high protein gluten and egg-free cookies with flaxseed by panelist

Ingredient	High protein gluten and egg-free cookies FI (g)
Wheat flour	-
High protein gluten-free flour composition	
Soy flour	48
Corn starch	19
M. arundinaceae flour	19
Tapioca flour	13
RS3 *M. arundinaceae* flour	15
RS3 *C. tuberosus* flour	1
Brown rice flour	35
Total gluten-free flour	**150**
Other ingredients	
Margarine	90
Egg	-
Flaxseed	10
Corn syrup	15
Salt	2
Cheddar cheese	75
Chocolate powder	5
Water	45

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