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Modified arrowroot starch and glucomannan for preserving physicochemical properties of sweet bread

Amido modificado de araruta e glucomanano na preservação das propriedades físico-químicas de pão doce

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ABSTRACT

Sweet bread is associated with smooth texture and high carbohydrate content, tasty and filling – quality that makes it preferred for snack. The key is in formulating raw material and other components. Commonly, sweet bread has short shelf life. Frozen dough could be the solution to this problem, and glucomannan addition during freezing process should be able to improve its physicochemical characteristics. This research aims to determine the effect of adding modified arrowroot (*Maranta arundinacea* L.) starch (MAS) as substitution, and glucomannan as frozen dough cryoprotectant toward sweet bread's physicochemical. Randomized Complete Block Design Factorial (RCBD) was applied, and two factors were studied. The first factor was modified arrowroot starch (0.00%, 3.75%, and 7.50%) and the second was glucomannan (0.0%, 0.5%, and 1.0%). The best result was combination between MAS 3.75% and glucomannan 0.5%, reaching dough expansion volume range of 50% to 60%, bread expansion volume range of 77% to 80%, hardness range of 2 N mm^{-2} to 3 N mm^{-2}, elasticity range of 88% to 96%, moisture content of 16% to 19%, ash content of 1.4% to 1.7%, fat content of 10% to 15%, protein content of 5%, and carbohydrate content of 51% to 66%. MAS is able to substitute wheat flour in bread production only if it is combined with glucomannan.

Index terms: Cryoprotectant; frozen dough; resistant fiber; retrogradation; shelf life.

RESUMO

O pão doce é caracterizado por apresentar textura macia, alto teor de carboidratos, sabor e recheio agradáveis que o tornam preferido para lanches rápidos. A chave está nas matérias-primas e outros componentes usados na sua formulação. No entanto, o pão doce possui vida de prateleira curta. O congelamento da massa pode ser usado para solucionar esse problema e a adição de glucomanano durante o congelamento pode melhorar suas características físico-químicas. O objetivo dessa pesquisa foi determinar o efeito do uso de amido modificado de araruta (*Maranta arundinacea* L.) como substituição e glucomanano como crioprotetor das propriedades físico-químicas da massa congelada de pão doce. O delineamento experimental em blocos inteiramente casualizados foi usado em esquema fatorial com dois fatores. O primeiro fator foi a adição do amido modificado de araruta em três níveis (0,00%, 3,75% e 7,50%) e o segundo fator foi o glucomanano em três níveis (0,0%, 0,5% e 1,0%). O melhor resultado foi a combinação de MAS 3,75% e glucomanano 0,5%, atingindo volume de expansão da massa de 50% a 60%, volume de expansão do pão de 77% a 80%, faixa de dureza 2 N mm^{-2} a 3 N mm^{-2}, faixa de elasticidade de 88% a 96%, teor de água de 16% a 19%, teor de cinzas de 1,4% a 1,7%, teor de gordura de 10% a 15%, teor de proteínas 5% e teor de carboidratos 51% a 66%. MAS é capaz de substituir a farinha de trigo na produção de pão apenas se for combinada com glucomanano.

Termos para indexação: Crioprotetor; massa congelada; fibra resistente; retrogradação; vida útil.

INTRODUCTION

Equally enjoyable among children and adults, sweet bread is quite a popular nibble. Soft, fluffy quality of fresh-from-the-oven product is irresistible, keeping demands on this foodstuff are at an all-time high. However, it is not uncommon for customers to be let down by how quickly it becomes damaged. Retrogradation is the key issue, since it not only decreases the already-short shelf life due to physiochemical reaction (Seetapan et al., 2015) but also causes loss of humidity which affects the texture and turn sweet bread stale (Luo et al., 2018).

Several studies had been conducted to prevent the problems by employing various attempts: controlling raw material and water proportions (Wang et al., 2016), utilizing wheat flour with high gluten content (Kondakci; Zhang; Zhou, 2015), maintaining homogenous structure in dough through stirring process (Öhgren; Fabregat; Langton, 2016), involving additives, optimizing freezing process and storing condition (Akbarian et al., 2015), applying composite flour made of wheat and cassava (Ortolan et al., 2015), and controlling freezing rate and terminal temperature (Ban et al., 2016).

Frozen dough technology has been around for quite some time since it is beneficial in attempts of cutting down time in both formulation processing and labor intensifying, increasing shelf life, upgrading product quality, and accommodating long-distance distribution (Chen et al., 2012). Although having some weaknesses – such as gluten capillaries disintegration and yeast viability decrease that can reduce product's volume and quality (Adams; Ragae; Abdel-aal, 2017) – this technique is applied to several bread production due to aforementioned advantages (Ban et al., 2016). The idea is to expand the technology to tackle existing disadvantages. The most common trouble possibly arise in frozen dough is altered texture and/or taste during freezing and storage process (Maity; Saxena; Raju, 2018). Adding cryoprotectant protects capillaries from crystal formulation during icing and thawing process (Maity; Saxena; Raju, 2018; Seetapan et al., 2015), while involving resistant fibers – like inulin and oat – helps to prevent staleness due to freezing (Adams; Ragaee; Abdel-aal, 2017; Setyobudi et al., 2019).

Arrowroot (*Maranta arundinacea* L.) contains resistant fiber that ferments in the colon and produces SCFA (Short Chain Fatty Acid) (Damat, 2013) the way inulin and oat do, and modified arrowroot starch has high content of resistant starch (RS) (Damat et al., 2019). Hypothetically, combining cryoprotectant application and modified arrowroot starch utilization should be able to let dough lasts longer. As there have not been any studies on this matter, the effect is unknown. Hence, this paper will analyse the effect of applying glucomannan as cryoprotectant and using modified arrowroot starch altogether towards sweet bread physicochemical.

Besides, it will also be analyzed its potential as a functional sweet bread as a result of increasing levels of resistant starch (RS). Resistant starch in food products can reduce the glycemic index of these products, so that it will reduce postprandial blood sugar levels (Damat, 2013). Foods that contain RS content can be used can be classified as functional foods (Raigond; Ezekiel; Raigond, 2015).

MATERIAL AND METHODS

Preparations and analyses were made at the Food and Microbiology Laboratories and UMM Bakery of University of Muhammadiyah Malang and carried out from January 2019 to April 2019.

Materials and equipment

Arrowroot (*Maranta arundinacea* L.) starch as the role material was obtained from farmers in the regency of Pamekasan in Madura (an island in the province of East Java), Indonesia. Glucomannan was obtained from CV. Nura Jaya, Surabaya, Indonesia. Chemical substances used were H_2SO_4, Ethanol, Folin-Ciocalteau, Sodium Potassium Tartrate, $CaCO_3$, Cu_2SO_4, H_3BO_3, and Aquades. Among equipment used were sifter (8-inch DIA× 2 inch [1 inch = 2.54 cm]), autoclave (model 91925, series B0004136), incubator (Incucell MMM), oven (WTC Binder 7200 type), texture profile analyzer (TPA EZ test model SM-500N-168), and glassware.

Experiment design

Randomized Complete Block Design Factorial (RCBD) – with tree replications – were employed. The first measure was the concentration of modified arrowroot starch (at 0.00%, 3.75%, and 7.50%), and the second one was glucomannan (0.00%, 0.50%, and 1.00%). Analysis of Variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) were also used.

Research implementation

Modification of arrowroot starch

The modification of arrowroot starch was carried out by adopting the method developed by Din, Xiong and Fei (2017). In arrowroot starch modification (MAS) forming, gelatinization and retrogradation methods were directed. The water-soluble starch was heated to 70 °C in aquades (20% b/v) for 10 min, and then further heated at 121 °C for 60 min, using an autoclave. Next, this starch suspension was placed at 24 °C for 1 h. It was subsequently followed by retrogradation for 24 h at 4 °C in the refrigerator. Afterward, the arrowroot starch was dried using a cabinet dryer at 50 °C for 28 h. The final steps were subtilizing and sifting (80 mesh).

Sweet bread production

Following is sweet bread production according to Park, Jang and Lim (2016), Wheat flour (100%; 96.25%; 92.5%), MAS (0%; 3.75%; 7.5%), sugar (25%), yeast (5%), eggs (5%), skimmed milk (6%), bread improver (0.5%), glucomannan (0%; 1 %; 1.5%) and water (45%) were mixed using a dough mixer for 10 min. Next, salt (1.5%) and butter (20%) were interspersed for 20 min until smooth. This dough was subsequently fermented (proofing) for 15 min at 20 °C, and then the gas formed in it was pulled out (degassing process) using the roller. Successively, thedough was divided into some parts (50 g each), molded, rested for 10 min (intermediate proofing), then wrapped in polypropylene and stored for 10 min at 30 °C. The freezing process conducted was for 7 d, at -15 °C. It was followed by the thawing process using an incubator for 60 min (30 °C). The last proofing process involved a proofer for 60 min (at 40 °C, with relative humidity [RH] 80% to 85%). Finally, the dough was baked using an oven for 20 min (180 °C).

Observed parameters

The parameters observed during the study cover dough expansion volume, sweet bread expansion volume, proximate composition, and bread structure.

i. To measure resistant starch (RS) (Hidayat et al., 2018). Resistant starch content of the sample was analyzed by spectroscopic methods. The sample was hydrolyzed using pepsin, α-amylase enzyme, and amyloglucosidase enzyme. Furthermore, the residue is added with 1 mL glucose assay kit solution (sigma GAGO-20). The absorbance reading of the sample used a spectrophotometer at a wavelength of 500 nm.

ii. To measure dough expansion volume (Park; Jang; Lim, 2016), the thawed dough was divided into three parts (12 g each) and fermented (35 °C) for 90 min at an RH of 85 % on a mass-cylinder.

iii. To measure sweet bread expansion volume, the loaves were weighed using analytical balance and the volume was recorded using rapeseed displacement method (official AACE International method 10-05-01). Furthermore, the specific volume was calculated by dividing the volume-expanded bread weight with sweet bread weight ($cm^3\ g^{-1}$) (Hamed et al., 2015).

iv. To measure bread composition, the sweet bread was analyzed for water content, gravimetric ash, fat, and carbohydrate concentrations (Thangaraj, 2016).

v. To measure bread texture, the sweet bread was assessed on its hardness and elasticity. The means was a texture analyzer (TPA EZ test model SM-500N-168) with cylinder diameter about 20 mm and depth pressure at 40% from bread length, and pressure velocity at 1 mm s^{-1}. The hardness was recorded in kgf (kilogram-force), and the elasticity was in % (percentage) (Park; Jang; Lim, 2016).

vi. To measure the swelling power and water water solubility, the sample is dispersed into distilled water (1:50 w/v) to form a suspension. The suspension was then incubated using a water bath at 95 °C for 30 min. Subsequently cooled at room temperature, and then centrifuged. The swelling power and the water solubility is calculated using the following Equation 1 and 2, (Astuti et al., 2018):

$$SP = [(\text{weight of precipitate} - \text{weight of dry sample}) / \text{weight of dry sample}] \times 100\% \quad (1)$$

$$WS = (\text{weight of dry solids in supernatant} / \text{weight of dry sample}) \times 100\% \quad (2)$$

vii. To measure oil holding capacity (OHC) and water holding capacity (WHC), the samples were stirred with cooking oil or distilled water (1:10 w/v) for 1 min and then centrifuged for 30 min. OHC and WHC are calculated using the Equation 3, (Astuti et al., 2018):

$$WHC \text{ or } OHC = [(\text{weight of wet precipitate} - \text{weight of dry sample}) / \text{weight of dry sample}] \times 100\% \quad (3)$$

Statistical analysis

The data were analyzed using Analysis of Variance (ANOVA) and were examined based on Duncan's New Multiple Range Test (DNMRT) with a rate of significance of 5%.

RESULTS AND DISCUSSION

Arrowroot starch characteristics

The comparison between natural and modified arrowroot starch is shown in Table 1. MAS's swelling power is proven higher than the natural one. The heating process using high-temperature water has caused strong vibration on the arrowroot molecules, consequently stopped hydrogen bonding. It allows the bonding process between water molecules and hydroxyl group in both amylose and amylopectin, increasing the starch granule volume as the result (Nogueira; Fakhouri; Oliveira, 2018).

Table 1: The natural and modified arrowroot starch characteristics.

Parameter	Natural	MAS
Swelling power (%)	9.54	16.28
Solubility (%)	4.00	8.38
Oil holding capacity (OHC) (%)	178	180
Water holding capacity (WHC) (%)	134	301
Resistant starch (%)	2.12	16.71

MAS also has higher solubility elevation than its natural form. It must be the effect of microstructural surface alteration, which enhances water absorption and component solubility (Hu et al., 2018). The solubility rate is also related to the presence of soluble amylose as starch component that was released and diffused from the starch granules during the swelling process (Zavareze; Dias, 2011). Previous study about potato starch showed that superheated steam at any temperature (between 100 °C to 160 °C) increased molecule mobility, affecting solubility decline in modified potato starch due to additional bindings among amylose-amylose and amylose-amylopectin interaction (Marta; Tensiska, 2017). Based on Table 1, it is known that modified arrowroot starch has a higher content of resistant starch when compared to the content of resistant starch in natural arrowroot starch. According to Hidayat et al. (2018), starch modification by gelatinization-retrogradation can increase levels of resistant starch.

Dough expansion volume

The result indicates that the interaction between MAS and glucomannan postulated fluctuating dough expansion volumes (Table 2). Dough expansion relies on the presence of polysaccharide – containing amylose and amylopectin – in wheat flour's gluten, and constant addition of MAS lead to a decline in its volume. An optimum process capable of creating better gluten structure is required to increase its extensibility and elasticity. Adding water also helps to establish the perfect viscoelasticity. Well-formed gluten is essential in the fermentation process, since it detains CO_2 in the dough under its elastic surface and is therefore able to maintain the optimum expansion volume (Srirejeki et al., 2018). MAS, apparently, could not fully replace wheat flour's role in dough production.

Glucomannan is a hydrocolloid that supports the stability of arrowroot-based product during freeze-thawing process due to its ability to minimize negative effects appearing in frozen dough. The incorporation of glucomannan as a cryoprotectant has also contributed in the dough expansion volume similar to previous studies (Ortolan et al., 2015). It was due to the total available glucose elevation and the presence of cryoprotectant on the yeast cell effect that allowed starch and hydrocolloid to interact and create complex polymer structure actively assisting the expanding process. Hydrocolloid addition in bread products was aimed to increase the dough storage stability by elevating humidity rate, decreasing bad smell that may form, and triggering structural changes in the dough's main components. However, it affected the physical and thermal aspects of starch and dough, such as gelatinization, retrogradation, fragmentation, and melting rate (Maity; Saxena; Raju, 2018).

Sweet bread expansion volume

The result indicates that sweet bread expansion volume were varied within 7 d (Table 3). The increase of MAS concentration resulted in the decline of expansion volume. This was, again, due to the lack of amylose and amylopectin – which could not retain as much CO_2 in the dough as wheat flour – as the main starch components. There must be a lot of CO_2 released during the heating process. It is also consistent with the previous studies – such as the addition of finger millet flour (Devani et al., 2016) and gluten-free flour (as in corn and rice flour) (Ballolli et al., 2014; Messia et al., 2016) – stating that the bread expansion volumes declined due to the treatment. The decrease of sweet bread expansion volumes were caused by soluble starch originated from gluten-free arrowroot starch. Conversely, wheat-based flour has significant impact on elasticity and surface making during the baking process (Devani et al., 2016), while MAS reduces CO_2 formation during fermentation.

Sweet bread texture

The texture of sweet bread became less smooth due to the addition of MAS (Table 4). Since it contained smaller amount of gluten due to less wheat flour involved, there was not enough water trapped in the dough.

Table 2: Power to expand sweet bread dough.

MAS (%)	Glucomannan (%)	Power to expand sweet bread dough on day to:			
		0	2	5	7
0.00	0.00	11.73bo	63.02c	57.39d	63.53e
0.00	0.50	10.67bo	66.90d	58.43de	51.85d
0.00	1.00	12.64bc	52.92b	61.26e	77.55f
3.75	0.00	11.90bc	62.92c	58.97de	51.94d
3.75	0.50	12.28bc	64.30c	71.09f	50.75c
3.75	1.00	13.26bc	74.52e	71.90f	51.97d
7.50	0.00	8.87a	48.98b	49.38c	43.22b
7.50	0.50	8.36a	42.07a	38.77a	42.87b
7.50	1.00	8.36a	42.29a	42.16b	41.50a

Note: Numbers in the same column followed by different alphabetic letters show significant differences based on the DMRT α = 5%.

Table 3: Sweet bread expansion volumes.

MAS (%)	Glucomannan (%)	Power to expand sweet bread on day to:			
		0	2	5	7
0.00	0.00	14.97bc	84.68e	76.43d	78.34bc
0.00	0.50	14.72b	84.01e	82.45d	72.62b
0.00	1.00	16.18c	72.65c	80.41d	84.55c
3.75	0.00	14.34b	78.81d	78.99d	64.72b
3.75	0.50	15.77c	77.34d	84.66d	74.04b
3.75	1.00	15.67c	83.68e	75.62d	67.55b
7.50	0.00	11.00a	61.12b	54.13b	54.17ab
7.50	0.50	10.56a	63.25b	63.51c	47.88a
7.50	1.00	10.40a	55.80a	50.92a	51.09a

Note: Numbers in the same column followed by different alphabetic letters show significant differences based on the DMRT α = 5%.

Table 4: Sweet bread texture levels.

MAS (%)	Glucomannan (%)	Texture (N mm^{-2})			
		0	2	5	7
0.00	0.00	0.92e	1.67a	5.29d	4.42c
0.00	0.50	0.96e	3.32c	4.73c	4.56c
0.00	1.00	0.43a	1.44a	2.21a	2.27a
3.75	0.00	0.71d	2.84b	3.24b	4.32c
3.75	0.50	0.59c	3.00c	3.29b	2.62a
3.75	1.00	0.47a	1.70a	2.35a	3.62b
7.50	0.00	1.51f	5.56d	7.34f	10.35d
7.50	0.50	1.60f	5.49d	6.30e	10.53d
7.50	1.00	1.73g	7.23e	7.31f	10.64d

Note: Numbers in the same column followed by different alphabetic letters show significant differences based on the DMRT α = 5%.

Arrowroot starch contains amylose which is quite high, which is around 24.64% (Faridah et al., 2014), which further affects the ability of water binding, and it prevents the dough from being elastic.

Glucomannan as a cryoprotectant was one of the hydrocolloids composing acetyl structures that act as water catcher, which affected the pores of crumb and bread structure.

Sweet bread elasticity

The addition of MAS significantly affected the elasticity of sweet bread (Table 5) as fluctuating values were recorded during the 7 d. Meanwhile, educed elasticity was affected by the addition of MAS, which augmented bread hardness due to the gelatinization process. MAS covered the sweet bread pores. It was also present among gluten layers of wheat flour. Conversely, the substitution process also increased the dough volume and reduced the pores size after fermentation.

The presence of gluten was needed to provide high elasticity, and cryoprotectant was also vital to prevent protein damage. Sweet bread production requires high protein wheat flour, containing intra disulfides and inter polypeptides bound among gliadin and glutenin sub-unit. This binding process should be able to create stable protein conformation. Glutenin could establish disulfide intra polypeptide that contributes to the high elasticity, since it can easily expand and provide high binding capacity with other molecules (Lu et al., 2017).

Sweet bread's crumb appearance

The crumb appearances of sweet bread analyzed are presented (Figure 1a to Figure 1i). The addition of arrowroot starch (0% and 7.5%) has significantly impacted to sweet bread crumb formation process, while MAS 3.75% addition has not changed it much. Smooth crumb development depended on gluten quality, yeast activity, and modified arrowroot starch substitution, while cryoprotectants saved protein (gluten) and yeast from damage during the freezing process. When yeast released CO_2, gluten enhanced elasticity to allow expanding properties of the dough during the fermentation process. As a result, the crumb appearance looked identical. Conversely, glucomannan also protects proteins from bigger pores crumb occurrence throughout the thawing process. Cryoprotectant should inhibit protein denaturation during freezing and storage period (Elliott; Wang; Fuller, 2017). It should also inactivate condensation through hydrogen water bonds creation. Additionally, cryoprotectant increased water's ability as binding agent, preventing water molecule substitution to protein, and stabilizing protein (Elliott; Wang; Fuller, 2017).

Sweet bread's proximate

The combination of MAS and cryprotectant influenced the water content alteration of sweet bread (Table 6). It was due to its capability to bind water and to inactivate condensation process by creating water bond via hydrogen. Higher water concentration in sweet bread was also obtainable due to larger amount of arrowroot starch assisting water absorption and binding processes.

Alleviation of MAS substitute and cryoprotectant increased the ash contents. Ash attributes to color stabilization, giving lighter hues to the crumbs. Hence, the usage of cryoprotectant could decrease the browning process on sweet bread's surface during baking period (Maity; Saxena; Raju, 2018).

Table 5: Sweet bread elasticity levels.

MAS (%)	Glucomannan (%)	Elasticity			
		0	2	5	7
0.00	0.00	17.56b	86.89a	88.46b	88.58b
0.00	0.50	17.51b	92.00b	86.62a	88.08b
0.00	1.00	17.62b	90.48b	94.95c	95.48e
3.75	0.00	17.67bc	96.47d	87.20ab	88.28b
3.75	0.50	18.30c	92.94bc	96.30d	91.95c
3.75	1.00	18.79c	94.01c	94.55c	94.38d
7.50	0.00	16.86ab	87.28a	87.08a	75.21a
7.50	0.50	16.73a	86.00a	88.37b	74.54a
7.50	1.00	16.19a	87.53a	86.31a	73.68a

Note: Numbers in the same column followed by different alphabetic letters show significant differences based on the DMRT α = 5%.

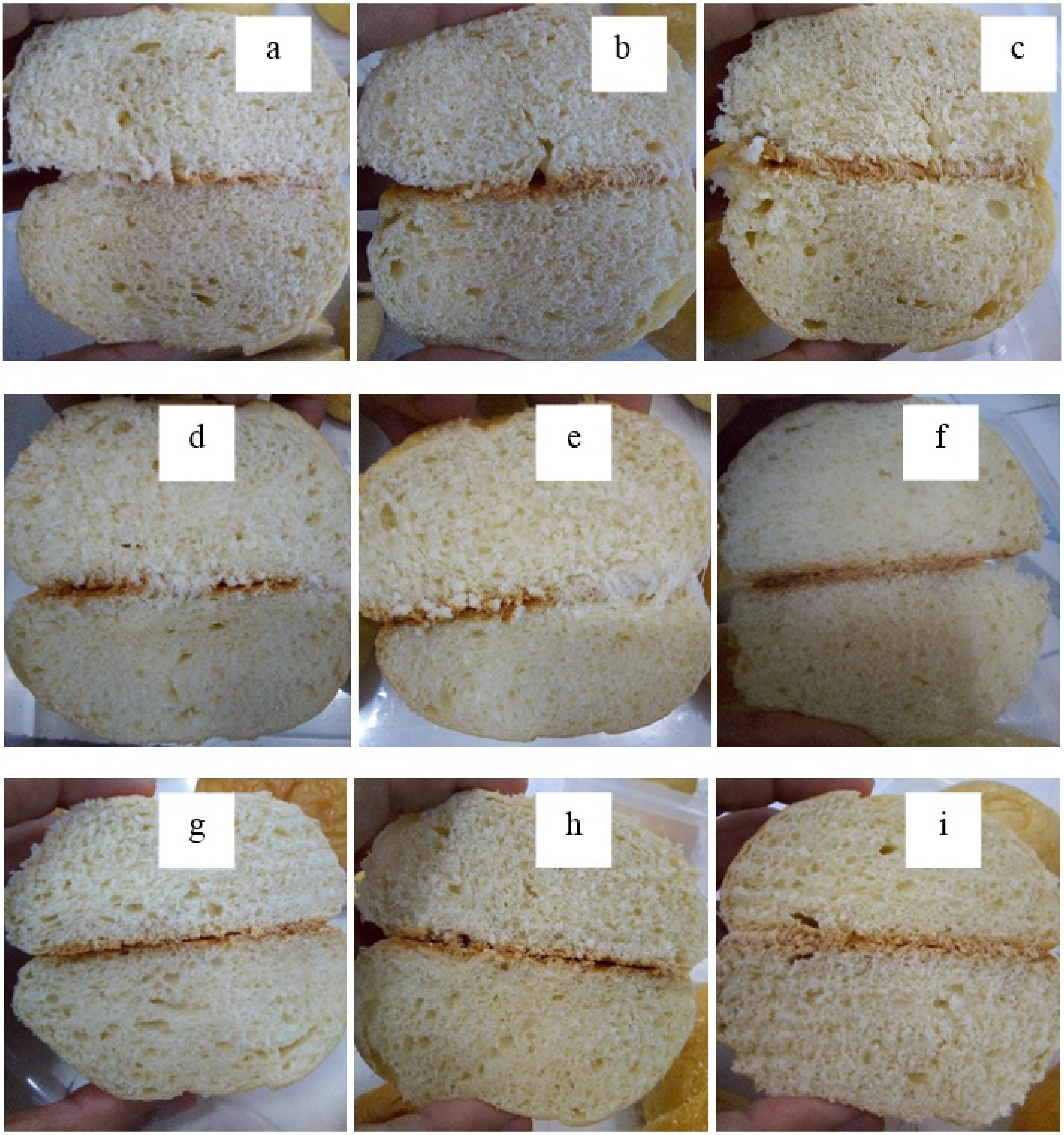

Figure 1: Sweet bread crumb appearances with MAS and glucomannan (a) 0%:0%; (b) 0%:0.5%; (c) 0%:1%; (d) 3.75%:0%; (e) 3.75%:0.5%; (f) 3.75%:1%; (g) 7.5%:0%; (h) 7.5%:0.5%; (i) 7.5%:1%.

Fat concentration relies on water and non-polar material bond. During the frozen dough storing process, the continuously increasing fat concentration was observed. This was due to cryoprotectant containing glucomannan that secured the dough. Furthermore, lipids can form complex compounds with starch and protein (Ortolan et al., 2015), thus increasing the protein content in bread.

Tabel 6: Sweet bread proximate properties.

MAS (%)	Glucomannan (%)	Water (%)	Ash (%)	Lipid (%)	Protein (%)	Carbohydrate (%)
0.00	0.00	19.79d	1.20a	13.70e	6.04bc	59.27a
0.00	0.50	20.67e	1.660b	10.06c	6.84c	60.77a
0.00	1.00	21.43f	1.67b	10.40d	6.02b	60.48a
3.75	0.00	18.04c	1.78b	10.51d	5.61b	64.06a
3.75	0.50	16.53b	1.55b	15.17f	5.45b	61.30ab
3.75	1.00	15.77a	1.66b	17.26f	5.52b	59.79a
7.50	0.00	15.29a	1.21a	4.40a	4.78ab	74.32d
7.50	0.50	16.51b	1.64b	9.31b	4.32a	68.22c
7.50	1.00	15.46a	1.64b	9.73b	4.20a	68.97c

Note: Numbers in the same column followed by different alphabetic letters show significant differences based on the DMRT α = 5%.

High MAS substitution can reduce protein content, because the protein content of arrowroot starch is quite low, only 0.24% (Faridah et al., 2014), while the use of cryoprotectant (0.5%) has supported the highest protein production in sweet bread. Furthermore, cryoprotectant maintains the amount of protein in dough inhibiting denaturation during freezing and storage processes, resulting in stable maintenance of total protein availability as well as intensification of water bond in bread (Maity; Saxena; Raju, 2018).

The concentration of carbohydrate has increased due to the substitution of MAS and addition of glucomannan. This is due to the high carbohydrate content in arrowroot starch, which is 98.74% (Faridah et al., 2014). MAS contains amylose and amylopectin as the main components – both considered as a polysaccharide (carbohydrate) – while glucomannan contains heteropolymer and mannose.

CONCLUSIONS

MAS is able to substitute wheat flour in bread production only if it is combined with glucomannan. The best result obtained is by applying 3.75% MAS, supported with glucomannan (0.5%). The physical properties cover dough expansion volume of 50% to 60%, sweet bread expansion volume of 77% to 80%, hardness level of 2.2 N mm^{-2} to 2.9 N mm^{-2}, and elasticity of 88% to 95%. Meanwhile, the chemical properties cover the appearance of homogenous crumb pores as well as water, ash, fat, protein, and carbohydrate contents of 16% to 19%, 1.4% to 1.7%, 10% to 15%, 5%, and 51% to 66% respectively.

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