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The effect of white sweet potatoes (*Ipomea batatas* L.) inulin extract addition on the characteristics of white bread with soybean flour substitution

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Abstract

White bread belongs to one of the most popular food products in the world, favoured by people for its delicacy and nutrients. Wheat flour is the main ingredient of white bread. White bread generally contains low dietary fiber. To reduce wheat flour usage, local ingredients such as local soybean can be used as an alternative to increasing the nutritional value. The addition of inulin can increase the level of dietary fiber. This research aimed to determine the chemical, physical, and sensory characteristics of white bread with soybean substitution and white sweet potatoes (*Ipomea batatas* L.) inulin extract addition and to determine the best formula. This research applied a Completely Randomized Design (CRD). The variations of soybean flour substitution were 0%, 20% and 24%, while the variations of white sweet potatoes inulin extract were 0%, 3% and 4%. The results showed that the treatment of substituting soy flour and adding white sweet potatoes inulin extract led to significant differences in the physical, chemical and sensory characteristics of the white bread. The chosen formula was F6 that consists of white bread with 24% soybean substitution and 3% white sweet potatoes inulin extract.

1. Introduction

Functional food refers to food containing certain physiological functions derived from animals or vegetables and can provide health benefits for those who consume it (Hasler, 2002). Tubers are one example of commodities that contain functional compounds. Sweet potatoes are one type of tuber that is abundant in Indonesia. The nutritional content found in sweet potatoes namely carbohydrates (starches and simple sugars), proteins, fats and fat-soluble vitamins (Marckzak *et al*., 2012). Abubakar *et al*. (2010) mentioned that sweet potatoes contain anti-diabetic, antioxidant and anti-proliferation compounds due to their nutritional and mineral compounds. Sweet potatoes can also be used for diabetics because it has a low glycemic index (Allen *et al*., 2012). White sweet potatoes have the potential to become a source of inulin. Arfiani (2016) found that yellow sweet potatoes have 4.6% inulin, purple sweet potatoes have 4.3% inulin, and white potatoes have the highest inulin level of 5.5%. Inulin refers to a carbohydrate that belongs to the fructan group and is included in the water-soluble fiber which helps to reduce blood lipids and stabilizes blood sugar (Marzeline and Annis, 2017). Inulin belongs to prebiotics which cannot be digested by digestive enzymes, but it can be fermented in the colon by *Bifidobacterium* bacteria which provide many health benefits to the body (Dewanti, 2013). Morreale *et al*. (2018) reported that inulin is a soluble dietary fiber that becomes an attractive material to be added to various foods.

As a substitute for tubers, soybean (*Glycine max* L.) can be a source of functional food and be used as a source of protein. It also contains nutrients such as carbohydrates, dietary fiber, minerals, vegetable fats and vitamins. Soybean is widely used since it provides health benefits, such as lowering cholesterol, preventing cancer, and preventing diabetes (Friedman and David, 2001). Superior varieties of Indonesian local soybeans such as Anjasmoro, Grobogan, and Malabar have large and yellow seeds and higher protein content compared to imported soybean. Grobogan soybean variety has several superiorities compared to other local soybeans, it has the highest protein (43.9%) and fat contents (18.4%) (Kristiana, 2014). In addition, Grobogan soybean does not contain preservatives and genetically modified organisms (GMO) (Astawan *et al*., 2013). Soybean flour is one of the processed soybean products that can be used as a substitute for making a food products (O'Keefe *et al*., 2015).

White bread has a sponge-like form and is mostly

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composed of gas bubbles (Wijayanti, 2007). Muflihati (2017) reported that white bread has low dietary fiber which results in a high glycemic index, it is necessary to innovate formulations in the process of making white bread. Several treatments carried out are expected to produce a low glycemic index for white bread. One effort made to reduce the glycemic index in white bread is by adding dietary fiber, which is obtained from white sweet potatoes inulin. In addition, to increase functional properties and reduce the amount of imported wheat, it is necessary to substitute wheat flour with soy flour for making white bread. This research aimed to determine the chemical, physical, and sensory characteristics of white bread with soybean substitution and white sweet potatoes inulin extract addition (*Ipomea batatas* L.) and to determine the best formula.

2. Materials and methods

2.1. Materials

White sweet potatoes of Korean variety taken from Matesih, Karanganyar, aqua dest (Merck), white sweet potatoes-flour, ethanol 95% (Merck), Grobogan soybean obtained from Rumah Kedelai Grobogan, soy flour, wheat flour, shortening, salt, sugar, water, bread improver, skimmed milk powder, yeast obtained from Toko Bahan Roti Ramajaya Solo. H_2SO_4 (Merck), K_2SO_4 (Merck), HgO (Merck), NaOH (Merck), $Na_2S_2O_3$ (Merck), HCl 0,02 N (Merck), H_3BO_3 (Merck), petroleum benzene (Merck), buffer Na phosphate pH 6 (Merck), pepsin enzyme 1% (Merck), ethanol 95% (Merck), enzyme α-amilase (Merck), Pankreatin (Merck), and Heksana (Merck).

2.2 Soy flour production

The soy flour was made by roasting the local soybeans for 45 mins by using a fire (60°C). The soybeans were then pounded to separate the epidermis. The next step was the winnowing stage which aimed to separate the epidermis from the soybean. The soybeans that had been separated from the epidermis were processed by the grinder and 60-mesh sieve (Regina *et al*., 2012).

2.3 Preparation of inulin extraction

The preparation of inulin extraction started with peeling, chopping, washing, drying by cabinet dryer, and turning the white sweet potatoes into flour. Preparation of inulin extraction began with peeling the white sweet potatoes, chopping them with a thickness of 1-2 mm, washing, and drying them with a cabinet dryer at a temperature of 50°C for 24 hrs. The sweet potatoes were then turned into flour by grinding and sieving them with an 80-mesh sieve (Kosasih *et al*., 2105).

2.4 Inulin extraction

The processes of sweet potato inulin extraction included mixing the flour and distilled water with a ratio of 1:5, soaking the flour in distilled water for 1 hr, heating in a water bath by stirring the solution at 80°C for 30 mins, filtering by using double-layered, and evaporating the solvents with a vacuum rotary evaporator at a temperature of 73°C, at a speed of 60 rpm, for 30 mins. The extraction process was carried out twice to ensure all the inulin was extracted (Kosasih *et al*., 2015).

2.5 Inulin isolation

The processes of inulin isolation consisted of setting the percentage of Brix of inulin extract at 30% Brix, soaking in 95% ethanol ratio 1:2 for 12 hrs, depositing with a centrifuge for 15 mins at a speed of 5000 rpm, and drying the inulin in an oven at 60°C for 6 hrs (Kosasih *et al.*, 2015). Inulin from the isolation process is packaged in airtight packaging or vacuum packaging which is then stored at room temperature.

2.6 White bread production

The white bread was made by weighing the ingredients (wheat flour, soy flour, shortening, salt, sugar, water, bread improver, skimmed milk powder, yeast, white sweet potatoes inulin extract) based on the formula. Next, flour, soy flour, granulated sugar, bread improver, skimmed milk powder, yeast, and white sweet potatoes inulin were combined using a mixer. The shortening and salt were added and the mixing was continued until the dough was smooth. The dough was then covered with a plastic wrap and let sit for 15 mins. The dough was then flattened using a rolling pin and the gas inside was reduced. The dough was rolled and placed in the baking pan. The dough was let sit again for 15 mins. Next, the dough was risen using a proofer for 1 hr at 40°C and RH 75-80%. The expansion dough was then put in an oven for 30 mins at a 180°C temperature. Finally, the dough was cooled at room temperature for 30 mins (Srirejeki *et al*., 2017).

2.7 Physical, chemical and organoleptic analysis

The physical analyses carried out included the baking expansion analysis using the Rap Seed Displacement Test method (Matz, 1972), texture analysis using the Llyod Universal Testing Machine method (Nourian and Ramaswamy, 2003), colour analysis using the Chromameter method (Hutching, 1999), where L* = lightness between 0 to 100 is white, a* = red between 0 and 60 and green between 0 and -60, b* = yellow between 0 and 60 and blue between 0 and -60. Meanwhile, the chemical analyses included the water

content analysis using the thermogravimetric method (AOAC, 2005), ash content analysis using dry ashing method (AOAC, 2005), protein content analysis using Kjeldahl method (AOAC, 2005), protein content analysis using Soxhlet extraction method (AOAC, 2005), carbohydrate content analysis using the by difference method (AOAC, 2005), dietary fiber content analysis using an enzymatic method (AOAC, 2005). Sensory evaluation used rating scale: 1) disliked, 2) quite disliked, 3) neutral, 4) quite liked, 5) liked (Setyaningsih *et al*., 2010).

2.8 Data analysis

The sensory, physical, and chemical data were analyzed statistically by applying the one-way ANOVA method. If the results were significant, the analyses were followed with a real difference test using Duncan's Multiple Range Test (DMRT) at the significance level of α=0.05.

3. Results and discussion

3.1 Baking expansion

Table 1 shows the increase in the amount of soy flour and white sweet potato inulin extract added to the white bread dough caused the lower bread dough expansion. The characteristic of soy flour that does not contain gluten will affect the bread dough baking expansion. Gluten acts as the skeleton of the bread that will trap CO_2 gas produced during the fermentation process that causes the dough to rise. The more gluten-free substitution flour used will lead to fewer CO_2 gas trapped inside the dough, resulting in bread with minimum expansion (Makinde and Akinoso, 2014). Inulin belongs to one source of fiber that obstructs the bread dough from expanding maximally. This is because fiber obstructs the gluten from capturing gases. The inulin mixed into the dough will inhibit gas storage and gas production (Elleuch *et al*., 2011). Wang *et al*. (2012) reported that adding fiber to the dough will hold up the work of gluten protein by suppressing and weakening the expanding dough. In addition, Mudgil *et al*. (2016) researched the addition of Partially Hydrolyzed Guar Gum (PHGG) to bread. The results showed that PHGG belongs to one source of dietary fiber. The more PHGG added, the lower the volume of the bread that can arise due to gluten damage caused by PHGG.

3.2 Texture

The increase in the addition of soy flour causes a greater force required to press the bread. It depicts that the texture of the white bread is becoming harder. This is due to the absence of gluten in soy flour used when making the white bread. The high gluten content will make the white bread dough elastic and able to form the structure of the bread and trap gas. Higher gluten content will result in better water absorption that more CO_2 gas is trapped and the bread will become tender (Wijayanti, 2007). The bread will be less and less tender if more and more sweet potato inulin extract is added because the inulin extract can weaken the gluten's ability to trap gas for expanding the bread dough. Lack of gas in the fermentation process will result in less bread volume and harder bread texture (Rubel *et al*., 2015).

3.3 Colour

The results of physical colour testing on white bread with soy flour substitution and white sweet potato inulin extract addition showed that the L* value ranges from 51.35-71.51. It shows that the colour of the white bread produced tends to be white since the value is close to 100. The a* value ranges from 1.77-10.87. It means that the colour of the white bread tends to be red since the value is close to 60. The b* value ranges from 13.42-26.49, which means that the colour of the white bread

Table 1. The physical characteristics of white bread with soybean flour substitution and white sweet potato inulin extract-addition

Formulation	Baking Expansion	Texture	Color (º)			
	(%)	(N)	L*	a*	b*	Hue
F1	242.45±0.92^{g}	1.34±0.05^{a}	71.51±0.22^{f}	1.77±0.10^{a}	13.42±0.11^{a}	85.44±0.11^{d}
F2	170.99±0.53^{f}	2.43±0.19^{e}	57.08±0.50^{d}	8.71±0.17^{b}	25.60±0.22^{c}	72.17±0.25^{bc}
F3	164.02±0.70^{e}	1.80±0.04^{c}	60.49±0.87^{e}	8.40±0.11^{b}	25.15±0.19^{bc}	72.74±0.19^{c}
F4	156.67±0.79^{c}	1.60±0.08^{b}	55.35±0.92^{c}	9.53±0.27^{c}	24.97±0.51^{b}	72.44±0.57^{bc}
F5	160.77±0.88^{d}	1.68±0.06^{bc}	53.41±0.24^{b}	10.87±0.29^{e}	26.49±0.25^{d}	70.55±0.21^{a}
F6	154.91±0.59^{b}	2.15±0.13^{d}	53.47±0.68^{b}	10.21±0.16^{d}	25.13±0.13^{bc}	72.02±0.18^{b}
F7	139.19±0.80^{a}	2.16±0.09^{d}	51.35±0.76^{a}	10.86±0.32^{e}	24.78±0.56^{b}	72.05±0.61^{b}

Values are presented as mean±SD. Values with different superscript within the same column are significantly different at α = 0.05. F1: 100% wheat flour (control), F2: 80% wheat flour + 20% soy flour + 0% white sweet potatoes inulin extract, F3: 80% wheat flour + 20% soy flour + 3% white sweet potatoes inulin extract, F4: 80% wheat flour + 20% soy flour + 4% white sweet potatoes inulin extract, F5: 76% wheat flour + 24% soy flour + 0% white sweet potatoes inulin extract, F6: 76% wheat flour + 24% soy flour + 3% white sweet potatoes inulin extract, F7: 76% wheat flour + 24% soy flour + 4% white sweet potatoes inulin extract.

tends to be yellow since the value is close to 60. The Hue value ranges from 70.55-85.44. The value is close to 90° which means it will result in yellow colour.

Increasing the amount of soy flour and white sweet potato inulin extract resulted in a dark bread colour (dark brown-yellow). The colour of the white bread is affected by the ingredients of the bread. This is because soy flour has a brownish yellow colour which comes from the yellow flavonoid pigment (Mugiarti, 2000). According to Rubel *et al*. (2015), the addition of inulin darkens the bread crust, it is shown by a lower L* value due to damage of some inulin mono and polysaccharides which result in a Maillard reaction. The high protein content in soy flour can stimulate the Maillard reaction. During the baking process, there will be a reaction between the free amino groups especially lysine with the reducing-sugar carbonyl group (Michalska *et al*., 2008). According to Jimenez *et al*. (2000), the Maillard reaction will become more and more intensive along with the higher protein content in the ingredients, which makes the bread darken.

3.4 Water content

Table 2 shows the substitution of soy flour and the addition of white sweet potato inulin extract affect the water content of the bread formulas. An increase in the amount of soy flour causes a reduced water content in bread because soy flour has less water content than wheat flour. According to Astawan and Khaidar (2016), the water content of soy flour is 6.71%, while according to SNI 01-3751-2006 the maximum water content of wheat flour is 14.5%. The low water content in the soy flour can bind water in the ingredients because there are starch and proteins in the ingredients that are able to bind water strongly. Based on a previous study, inulin has 69.31% solubility and 20.99 hygroscopicity (Yudhistira and Choiriyah, 2021). Hence, the more soy flour used, the lower the water content of the product (Parinduri *et al.*, 2016). Furthermore, Waruwu *et al*. (2015) mentioned that the increase in soy flour amount in the white bread-making process will lower the water content because soy flour contains more fat compared to wheat flour which cannot bind to water. In a previous study, in marshmallow products the addition of inulin white sweet potato extract and sorbitol caused the water content to increase (Yudhistira *et al*., 2021).

The higher the addition of white sweet potato inulin extract, the less the water content in the white bread. According to Morreale *et al*. (2018), inulin is a polysaccharide taken from plants and is included as a soluble dietary fiber. Adding inulin extract (polysaccharide) to the ingredient will affect the process of water absorption. High fiber content will increase water absorption. It occurs because, within the fiber, there are quite a lot of polar-free hydroxyl groups (Praseptiangga *et al*., 2016). According to the National Standardization Agency of Indonesia (1995), the maximum water content for bread is 40% (SNI 01-3840-1995). Thus, the results of this research have been in accordance with the standard set by the agency.

3.5 Ash content

The addition of soy flour and the addition of white sweet potato inulin extract which was increasing resulted in higher ash content. The ash content obtained in this research exceeded the maximum standard of SNI 01-3840-1995 for white bread quality standard, which is 1% minimum. It happens because the soy flour substitution and white sweet potato inulin extract addition provide higher ash content compared to the wheat flour. The ash

Table 2. The chemical characteristics of white bread with soybean flour substitution and white sweet potato inulin extract-addition

Formulation	Parameter					
	Water Content (%wb)	Ash Content (%wb)	Protein Content (%wb)	Fat Content (%wb)	Carbohydrate Content (%wb)	Dietary Fiber Content (%wb)
F1	34.72±0.08^{g}	1.65±0.06^{a}	6.42±0.33^{a}	3.48±0.05^{a}	53.72±0.34^{e}	3.77±0.11^{a}
F2	34.33±0.04^{f}	3.15±0.09^{b}	9.99±0.35^{bc}	7.69±0.05^{d}	44.82±0.21^{b}	8.45±0.42^{b}
F3	33.40±0.03^{c}	3.47±0.05^{c}	9.21±0.22^{b}	7.46±0.05^{c}	46.44±0.18^{c}	9.93±0.15^{c}
F4	33.24±0.09^{b}	3.64±0.04^{d}	9.01±0.34^{b}	6.74±0.09^{b}	47.35±0.31^{c}	10.48±0.16^{c}
F5	34.07±0.01^{e}	3.52±0.09^{c}	10.23±0.59^{c}	8.88±0.02^{g}	43.28±0.69^{a}	11.45±0.53^{d}
F6	33.82±0.10^{d}	3.80±0.04^{e}	10.23±0.98^{c}	8.44±0.02^{f}	43.69±1.10^{a}	11.83±0.36^{de}
F7	32.75±0.11^{a}	3.90±0.02^{e}	9.85±0.45^{bc}	8.06±0.09^{e}	45.42±0.62^{b}	12.14±0.38^{e}

Values are presented as mean±SD. Values with different superscript within the same column are significantly different at $\alpha = 0.05$. F1: 100% wheat flour (control), F2: 80% wheat flour + 20% soy flour + 0% white sweet potatoes inulin extract, F3: 80% wheat flour + 20% soy flour + 3% white sweet potatoes inulin extract, F4: 80% wheat flour + 20% soy flour + 4% white sweet potatoes inulin extract, F5: 76% wheat flour + 24% soy flour + 0% white sweet potatoes inulin extract, F6: 76% wheat flour + 24% soy flour + 3% white sweet potatoes inulin extract, F7: 76% wheat flour + 24% soy flour + 4% white sweet potatoes inulin extract.

content of soy flour is 1.99% (Astawan and Khaidar, 2016), while the ash content of wheat flour is 0.70% maximum (National Standardization Agency of Indonesia, 2006). The amount of ash content also depends on the amount of mineral content used. Etiosa *et al*. (2017) reported that the mineral contents within soybeans consist of calcium, magnesium, iron, cadmium, sodium, zinc, and phosphorus. The process of making the ingredients is also influential. The improper process of soy flour and inulin causes a higher content of inorganic residue (ash) compared to wheat as a product that has undergone bleaching and purification processes (Wijayanti, 2007).

3.6 Protein

The results of this research showed that the protein content of white bread with soy flour substitution was higher than the bread without flour substitution. The protein content in white bread is influenced by the ingredients of the flour used. According to Astawan and Khaidar (2016), the protein content of Grobogan-soy flour is 46.10%. The number is higher than the protein content of wheat flour, which is only 7.0% (National Standardization Agency of Indonesia, 2006). In addition to the other ingredients, non-fat skim milk also contributes to several proteins in bread (Wijayanti, 2007).

3.7 Fat

White bread with soy flour substitution has higher fat content compared to white bread without substitution. An increase in the number of substitutions of soy flour in white bread causes a greater fat content. It is because soy flour has a fat content of 38.65% (Astawan and Khaidar, 2016). Grobogan soybean variety, according to Kristiana (2014), it has the highest fat content compared to other types of soybean, which is only 18.4%. Soybean is a type of legume that produces fat (Parinduri *et al*., 2016). Besides soy flour, another ingredient that affects the fat content is shortening. Shortening gives around 4% fat content in the white bread (Chin *et al*., 2010).

3.8 Carbohydrate

This research showed that the carbohydrate content in the white bread without treatment was greater than in the substituted white bread with the addition of inulin extract. It is because soy flour has lower carbohydrate content (13.26%) (Astawan and Khaidar, 2016) compared to wheat flour which has 74.22% carbohydrate content (USDA, 2014). Meanwhile, the carbohydrate content of substituted white bread without the addition of inulin extract is smaller than substituted white bread with the addition of inulin extract. Inulin is a carbohydrate obtained from plants and is categorized as a prebiotic. Therefore, the carbohydrate content will get higher along with the increase of inulin extract (Melanie *et al*., 2015).

3.9 Dietary fiber

The increasing addition of inulin extract causes greater fiber content. Inulin belongs to one of the food components widely used due to the high content of dietary fiber (Shoaib *et al*., 2016). Besides soluble dietary fiber, inulin is also included as a prebiotic. Inulin is prebiotic which cannot be digested by digestive enzymes, it is also water-soluble. Tubers such as white sweet potato are one of the inulin sources. White sweet potatoes have the highest inulin level (5.5%), compared to other types of sweet potatoes (Arfiani, 2016). Huang *et al*. (1999) reported that white sweet potatoes contain a high amount of dietary fiber of 2.3–3.3 g/100 g of body weight. In a previous study, the amount of inulin in yellow sweet potatoes reached 7.66% (Yudhistira, Siswanti and Anindita *et al*., 2020) and 6.87% in white sweet potatoes (Yudhistira *et al*., 2019), both using different solvents and soaking times. Meanwhile, Yudhistira *et al*. (2020) obtained 22.53% inulin with foam mat drying treatment. Thus, the addition of white sweet potato inulin extract will increase the dietary fiber in the white bread.

3.10 Bread colour

Colour is the first parameter evaluated by consumers when assessing the quality of a food product (Purlis, 2010). The panellists' preference level ranges from 2.92–4.75. It can be inferred that the white bread has a scale of 'quite dislike' to 'quite like'. A good white bread has criteria of brownish-yellow crust and creamy white crumb (Mudjajanto and Yulianti, 2004). Meanwhile, SNI 01-3840-1995 suggested that the quality standard colour of white bread should be normal (typical bread). The addition of soy flour and white sweet potato inulin extract resulted in a darker brownish yellow colour in white bread. The colour of the Grobogan-soy flour used for the substitution is brownish yellow. Therefore, another method is needed to make the colour of Grobogan-soy flour not too brownish. Mugiarti (2000) argued that the flavonoid pigment of the soybean makes the colour of soy flour turn brownish yellow, thus resulting in a darker colour of white bread. In the research conducted by Peressini and Alessandro (2009), adding bread with inulin ST (chicory Raftiline ST) will result in a darker colour of the bread compared to the bread with inulin HP (chicory Raftiline HP). It happens because inulin ST has a higher reducing-sugar content than inulin HP, so there will be a more intensive Maillard reaction.

3.11 Bread aroma

Table 3 shows the panellists' preference level for aroma ranges from 3.02-4.75. It can be interpreted that the aroma has a scale of 'neutral' to 'quite like'. According to SNI 01-3840-1995, the standard quality for the white bread aroma (smell) is that it should be normal. Meanwhile, according to Mudjajanto and Yulianti (2004), a good white bread should have a fragrant, typical-bread aroma. The substitution of soy flour into the bread reduces the panellists' preference level. It is caused by the unpleasant smell of the soybean. According to Parinduri *et al*. (2016), the unpleasant smell causes a deviation of taste and aroma of the product, it affects the assessment of the product. The unpleasant aroma of the soy is caused by the lipoxygenase enzyme which breaks down soybean fat into compounds that are included in hexanal and hexagonal groups (Mugiarti, 2000). However, by adding white sweet potato inulin extract into the bread, the panellists' preference level increases. The white sweet potato inulin has no aroma (neutral). Therefore, the inulin will reduce or neutralize the unpleasant aroma of soy flour.

3.12 Bread taste

The panellists' preference level for the taste ranges from 2.50-4.40. It means that the taste has a scale of 'quite dislike' to 'quite like'. According to SNI 01-3840-1995, the standard taste for white bread should be normal (typical bread). Mudjajanto and Yulianti (2004) reported that good white bread should have a rather tasty and savoury taste. The more soy flour substitution and white sweet potato inulin extract added, the lower the panellists' preference level. The white bread produced has a bitter aftertaste. The unpleasant taste in soy flour lowers the panellists' preference level. In addition, soybeans also have compounds such as glycosides that stimulate a bitter taste; and isoflavones and aglycones that cause a chalky taste (Ginting, 2010).

3.13 Bread texture

The panellists' preference level for the texture ranges from 2.92 – 4.15, which means that the bread has a scale of 'quite dislike' to 'quite like'. Mudjajanto and Yulianti (2004) stated that a loaf of good white bread should have a soft and elastic taste. The increase in soy flour and white sweet potato inulin extract resulted in a lower level of panellist preference. It happens because the texture of the white bread is getting harder. The soy flour does not contain gluten which functions as a bread riser, thus causing the dough to be less able to hold the gas (Nur'aini, 2011). In addition, inulin has a high fiber content which will improve the ability to absorb water and reduce the amount of water in the dough (Praseptiangga *et al*., 2016) that the texture of the bread becomes hard and brittle.

3.14 Overall

Table 3 shows the panellists' overall preference level for the white bread with soy flour substitution and white sweet potato inulin extract ranging from 2.75–4.55. So overall, all the bread formulas have a scale value of 'quite dislike' to 'quite like'. The substitution of soy flour and the addition of white sweet potato inulin extract caused a decrease in the panellists' preference for white bread produced. So, the overall preference is influenced by the colour, aroma and taste. The most preferred formula for soy flour substitution and white sweet potato inulin extract-addition other than the control (F1) is F2, which is white bread with 20% soy flour substitution and without the addition of white sweet potato inulin extract.

Table 3. The sensory characteristics of white bread with soybean flour substitution and white sweet potato inulin extract-addition

Formulations	Parameter				
	Color	Aroma	Taste	Texture	Overall
F1	4.75±0.54^{e}	4.75±0.67^{d}	4.40±0.70^{c}	4.15±0.73^{d}	4.55±0.55^{d}
F2	3.90±0.77^{d}	3.40±0.92^{bc}	3.52±0.93^{b}	3.48±0.90^{c}	3.75±0.77^{c}
F3	3.68±0.73^{cd}	3.52±0.75^{bc}	2.28±0.98^{a}	3.28±0.84^{bc}	3.15±0.62^{b}
F4	3.50±0.78^{bc}	3.70±0.79^{c}	2.50±0.93^{a}	2.92±0.88^{ab}	3.10±0.63^{ab}
F5	3.62±0.77^{cd}	3.02±0.80^{a}	3.42±0.98^{b}	3.45±0.84^{c}	3.48±0.78^{c}
F6	3.25±0.42^{ab}	3.18±0.67^{ab}	2.38±0.84^{a}	2.95±0.93^{ab}	2.88±0.75^{ab}
F7	2.92±0.79^{a}	3.55±0.78^{c}	2.50±0.97^{a}	2.75±0.92^{a}	2.80±0.75^{a}

Values are presented as mean±SD. Values with different superscript within the same column are significantly different at $\alpha = 0.05$. F1: 100% wheat flour (control), F2: 80% wheat flour + 20% soy flour + 0% white sweet potatoes inulin extract, F3: 80% wheat flour + 20% soy flour + 3% white sweet potatoes inulin extract, F4: 80% wheat flour + 20% soy flour + 4% white sweet potatoes inulin extract, F5: 76% wheat flour + 24% soy flour + 0% white sweet potatoes inulin extract, F6: 76% wheat flour + 24% soy flour + 3% white sweet potatoes inulin extract, F7: 76% wheat flour + 24% soy flour + 4% white sweet potatoes inulin extract.

3.15 Determining the best formula for white bread with soybean flour substitution and white sweet potato inulin extract-addition

The best formula was determined using the Effectiveness Test of De Garmo *et al*. (1984). The best formula was chosen based on physical, chemical, and sensory characteristics. The formula value indicated 0–0.25 = ineffective; 0.26–0.50 = less effective; 0.51–0.75 = effective; 0.76-1.00 = very effective. The best formula referred to the treatment with the highest score of product's importance expected by the consumers. Table 4 shows that the best formula with the highest value is 76% flour + 24% soy flour + 3% white sweet potato inulin extract (F6) show 0.5894.

Table 4. The effectiveness values of white bread with soy flour substitution with white sweet potato inulin extract-addition

Formulations	Effectiveness Values
F2	0.5800
F3	0.4606
F4	0.4255
F5	0.5841
F6	0.5894
F7	0.5531

F1: 100% wheat flour (control), F2: 80% wheat flour + 20% soy flour + 0% white sweet potatoes inulin extract, F3: 80% wheat flour + 20% soy flour + 3% white sweet potatoes inulin extract, F4: 80% wheat flour + 20% soy flour + 4% white sweet potatoes inulin extract, F5: 76% wheat flour + 24% soy flour + 0% white sweet potatoes inulin extract, F6: 76% wheat flour + 24% soy flour + 3% white sweet potatoes inulin extract, F7: 76% wheat flour + 24% soy flour + 4% white sweet potatoes inulin extract.

4. Conclusion

The physical characteristic of white bread with soy flour substitution and white sweet potato (*Ipomea batatas* L.) inulin extract addition showed a significant difference. The addition of soy flour and white sweet potato inulin extract which was increasing resulted in low swelling power in bread dough. It will also harden the texture and darken the colour of the white bread. The chemical characteristic of white bread with soy flour substitution and white sweet potato (*Ipomea batatas* L.) inulin extract addition showed a significant difference. Meanwhile, the addition of soy flour and white sweet potato inulin extract which increased caused a decrease in water and fat content, and increased ash content, protein, carbohydrates, and dietary fiber. The sensory characteristic of white bread with soy flour substitution and white sweet potato (*Ipomea batatas* L.) inulin extract showed a significant difference. The panellists' preference level was lower as the addition of soy flour and white sweet potato inulin extract increased. The chosen formula of white bread with soy flour substitution and white sweet potato inulin extract was bread with 24% soy flour substitution and 3% white sweet potato inulin extract addition.

Conflict of interest

The authors declare no conflict of interest.

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