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Retno Utami Hatmi – BPTP Yogyakarta

Arya Wirabhuana – UIN Sunan Kalijaga Yogyakarta

Yeyen Prestyaning Wanita – BPTP Yogyakarta

Edi Tando – BPTP Sulawesi Tenggara

Musyadik – BPTP Sulawesi Tenggara

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The Effect of the Polishing Process and Sorghum Type (Brown and White) on the Content of Crackers Nutrition

***Retno* Utami Hatmi[1]*, *Arya* Wirabhuana[2], *Yeyen* Prestyaning Wanita[1], *Edi* Tando[3] dan *Musyadik*[3]**

[1]Assessment Institute for Agricultural Technology Yogyakarta
[2]UIN Sunan Kalijaga Yogyakarta
[3]Assessment Institute for Agricultural Technology Sulawesi Tenggara

Abstract. Yogyakarta - Indonesia has a variety of types of sorghum. Antioxidants and protein are among its nutritional advantages. Processing technology innovation is still needed to optimize its nutrition. Polishing is the main process in sorghum. This study aims to determine the effect of polishing and types of sorghum (brown and white) on the nutritional content of sorghum crackers. Nutrient content analyzed included water, ash, protein, fat, crude fiber, carbohydrate, energy, and beta carotene content. We found that the polishing process of the two types of sorghum resulted in different nutritional advantages of the sorghum crackers. The water, protein, fat, and crude fiber content of sorghum crackers decreased from the initial nutrient content of sorghum grain. Conversely, the content of ash, carbohydrates, and energy increase after becoming crackers. Polishing of white and brown sorghum grain causes higher content of ash, protein, energy, and beta carotene in sorghum crackers compared to unpolished ones. The crackers made from polished white sorghum grain had a higher protein content (7.74%) than those from polished brown sorghum grain (5.71%). The crackers made from polished brown sorghum grain had nutritional advantages in the content of ash (2.78%), energy (333.92 calori/100g) and beta carotene (2134.16mg/100g) compared to crackers made from polished white sorghum grain (2.66%; 317.23 calori/100g; 53.01mg/100g). Polishing of white sorghum grain produces high protein crackers, while polishing of brown sorghum grain produces crackers with high functional beta carotene content.

1. Introduction

Sorghum is an inferior food crop in Yogyakarta, Indonesia. The use of sorghum as food is still very limited. Sorghum diversification is not as good as rice and maize. The area for sorghum development in Yogyakarta is in Gunungkidul Regency [1]. This is in accordance with the ability of sorghum plants that grow in sub-optimal land (tolerant of drought and less fertile). In 2017, the harvest area for sorghum in Gunungkidul reached 96 ha with a total production of 31 tonnes [2]. In general, sorghum is still used as animal feed. However, in several areas in Gunungkidul, sorghum has been processed into food. One of the products is sorghum crackers.

Sorghum, according to the color of the grain, is very diverse (white, yellow to red, brown, and purple). The color of these grains is determined by the color and thickness of the outer skin (pericarp), the presence of pigments in the testa layer, and the secondary color of the plant [3].

The basic nutrient content of sorghum (protein, fat, carbohydrate, crude fiber, ash, and energy) is able to compete with other foodstuffs, such as rice, corn, wheat, and millets [4–6]. Aside from being a source of calories, sorghum nutrition composition is dominated by carbohydrates 83.29% b/k and protein 11.38% b/k [7]. Sorghum protein levels are relatively high, but their use is still limited. This is due to poor protein digestibility [6]. Sorghum has an amino acid composition (tyrosine, lysine, leucine, isoleucine) whose availability is higher than rice and corn [8,9]. Sorghum also has essential and functional nutrients, including antioxidant compounds, dietary fiber, oligosaccharides, vitamin B complex (thiamine, riboflavin, niacin), β glucan, and β carotene - precursors of vitamin A, minerals (Ca, Fe,), anthocyanin [5,6,8–12].

Sorghum also contains tannin. Tannins are polyphenol compounds found in the outer skin layers of sorghum (pericarp). Its existence has limited the use of sorghum as a food product. Tannins in sorghum have weaknesses and advantages as a nutrient and anti-nutrient. As an anti-nutrient, tannin causes dull product color, a slightly bitter taste, and inhibits the activity of digestive enzymes. Tannins, as nutrients, contain antioxidants that are higher than vitamins A and C [10]. The color of sorghum grains cannot be a reference to high and low levels of tannins [12–14]. Most of the tannins in sorghum are not condensed, so they are non-toxic, increase fiber content, and can be consumed for food [15]. The tannin content in sorghum will inhibit the use of carbohydrates, proteins, and minerals. Treatment such as soaking, steaming, pressure cooking, malting, pearling, and extrusion, can significantly reduce anti-nutrient levels [16].

Crude fiber, pigments, and wax found in the outer layer of sorghum grains (pericarp) are difficult to digest [7] and give a bitter taste. Pericarp can be eliminated by the polishing method [16,17]. Polishing is the process of removing the outer skin of sorghum and germ without damaging the aleuron and endosperm layers [18]. The polishing can be done manually or mechanically (abrasives or alkalis). The use of an abrasive type polishing machine with two times of polishing gives the quality of whole grains 91.16% - 94.40%, broken grains 3-6%, brightness value 46.66%, and tannin content 0.09% [19]. The quality of the polishing product is largely determined by the nature of sorghum grains (grain size, the thickness of the pericarp, grain color, the hardness of the grain, and endosperm) [20]. The polishing can reduce tannin levels up to 75%, depending on the type of variety and moisture content [18,21]. The degree of polishing has a significant effect on decreasing water content, water absorption, solubility, and tannin content in sorghum flour [22]. The duration of polishing is mostly determined by the characteristics of sorghum grain, techniques, and polishing equipment used.

The basic, essential, and functional nutrients in sorghum provide excellent opportunities for the Development of food products. The utilization of sorghum as food is not optimal, both as intermediate products and products ready for consumption. At this time, sorghum products still play a role as a source of carbohydrates. This research leads to the processing of sorghum products by paying attention to essential nutrients (proximate) and functional nutrients (β carotene). Bejiharjo Village Karangmojo Gunungkidul has developed sorghum-based snacks, i.e., sorghum crackers. The purpose of this study was to determine the effect of polishing and type of sorghum (brown and white) on the nutritional content of sorghum crackers.

2. Material and Methods

2.1. Material

The research material (brown and white sorghum grain) was obtained from Karangmojo Gunungkidul Yogyakarta. Sorghum flour prepared according to the method [23] and [24] were modified (Fig 1.). Sorghum grains were abrasively polished for 2 minutes into sorghum rice. Then, sorghum rice is milled with a hammer mill and sieved using a mesh 60. Sorghum flour is ready to be processed into crackers [25].

2.2. Methods

The experimental design used was a completely randomized design (CRD) with two factors, namely the type of sorghum grain (white and brown) and the sorghum processing method (with polishing and without polishing) with six replications. Laboratory analysis was carried out on two types of sorghum grain (brown and white sorghum) and sorghum derivatives (crackers) made from two types of sorghum grain with polishing and unpolished treatments. Nutritional parameters were analyzed using a reference to [20,26], including moisture content, ash content, protein, fat, carbohydrates, crude fiber, and starch (amylose and amylopectin). Meanwhile, energy measurement used a bomb calorimeter. Sorghum derivative products (i.e., sorghum crackers) were also analyzed using [20,26] with the same nutritional parameters. Another essential nutrient that was also analyzed is beta-carotene. Beta carotene was analyzed using spectrophotometry with a wavelength of 451 nm [27].

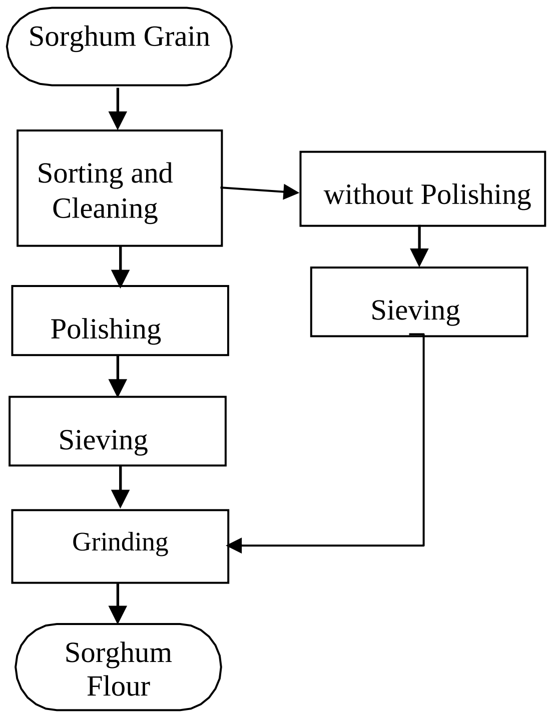

Figure 1. The making process of sorghum flour

3. Result and Discussion

3.1. The nutrition of sorghum grain

This study uses two types of sorghum, namely red and white. Laboratory tests are carried out to analyze the basic nutrient content (water content, ash content, protein, fat, crude fiber, and carbohydrates), energy, and starch composition (amylose and amylopectin) before the processing of cracker products takes place. This analysis also includes several other cereal nutrition references as a comparison (Tabel 1.).

Table 1. The basic nutritional content of several types of cereals

Type of Cereal	Water (%)	Ash (%)	Protein (%)	Fat (%)	Crude fiber (%)	Carbohydrate (%)	Energy (kcal)
Brown Sorghum* (b/b)	14,71	1,64	8,93	1,53	10,31	62,87	294,07
White Sorghum* (b/b)	13,29	1,62	8,58	1,82	9,03	65,65	305,90
Sorghum[1]	12,00	1,60	10,40	3,10	2,00	70,70	329,00
Sorghum[2]	10,60	2,80	10,38	2,80	5,18	73,39	-
Brown rice[1]	12,00	1,30	7,90	2,70	1,00	76,00	362,00
Corn[1]	12,00	1,20	9,20	4,60	2,80	73,00	358,00
Wheat[1]	12,00	1,60	11,6	2,00	2,00	71,00	342,00
Millet[1]	12,00	2,60	7,7	1,50	3,60	72,60	336,00

Source: [1] = Dep. of Health-RI (1992), [2] = Sukarminah (2015)

Note: * = sorghum grains have not been mill

3.1.1. Water and Ash Content

The main component of food is water. Water in food plays a role in determining the level of freshness, storability, quality, appearance, texture, and taste. Sorghum nutrition, in general, does not differ significantly from other types of cereals. In Table 1. the water content of sorghum grain (brown and white) is still relatively high (13.29% and 14.71%) compared to other milled reference sorghum grain. This is because the analyzed sorghum grains are grains that have not yet been milled. Drying sorghum grain is done two times before and after threshing. The drying stage is determined by the surface area of the material, thickness, temperature, and aeration. Water content before threshing is expected to range between 12-14% to minimize broken seeds, while water content after threshing is expected to be a maximum of 12% [28].

Ash content is the remaining mineral elements or inorganic substances from the combustion process during ash analysis. The value of sorghum grain ash (brown and white) is equivalent to wheat but higher than brown rice and corn, which is around 1.6%. Sorghum grain ash content (brown and white) is in accordance with that delivered by [7], that sorghum grain ash content ranges from 1.2% - 2.2%.

3.1.2. Protein and Fat

Protein is an arrangement of amino acids that are bound by peptides to form complicated organic matter. The structure and properties of a protein are determined by its composition, type, amount, and composition of amino acids. Protein in sorghum is the second-largest nutritional component after carbohydrates, which consists of prolamin/kafirin, albumin, globulin, and glutelin [7,12]. The results of the analysis showed that the sorghum protein (brown and white) was higher compared to brown rice and millet but lower than wheat and corn. In Table 1. there are variations in sorghum protein levels ranging from 8.58% to 10.40%. Meanwhile, according to [11], 13 varieties of sorghum have varying protein content between 7.39% - 9.86%. Variation in protein content and composition is strongly influenced by genotype factors, water availability, temperature, soil fertility, and environmental conditions during the growth of sorghum grain [29].

Fats in food will determine the quality, shelf life, taste, and characteristics of the product. The fat content in sorghum grain is relatively low compared to other food ingredients but relatively comparable to other types of cereals. Sorghum fat consists of three fractions, namely neutral fraction (86.2%), glycolipids (3.1%) and phospholipids (0.7%) [11]. Sorghum fatty acids are dominated by linoleic acid (49%), oleic acid (31%), and palmitic acid (14%) [29]. The results of the analysis showed that sorghum grains (brown and white) had a fat content ranging from 1.53 to 1.82%, while according to other references, sorghum grain fat content could reach 2.80-3.10%. It can be concluded that sorghum grain fat content ranges from 1.53-3.10%. This is consistent with what was delivered by [9,11], that the fat content of sorghum grain ranged from 1.45 to 3.8%. Table 1. shows that the highest fat content of the five types of cereals is corn.

3.1.3. Carbohydrate, Energy, and Crude fiber

Carbohydrates are a source of calories/energy for living things. Carbohydrates in sorghum grains are the main nutritional component. The results of the analysis showed that the carbohydrate value of sorghum grains (brown and white) was the lowest compared to reference sorghum or other cereals, ranging from 62.87 to 65.65%. These results are consistent with the statement of [11], which states that sorghum carbohydrate content is relatively lower compared to other cereals.

Carbohydrate levels are directly proportional to the value of the energy produced. Energy generated from carbohydrate values of 62.87% is below 300kcal, while carbohydrate content in the range of 65-73% makes the energy of 300-350kcal. According to [30], the carbohydrate content of white sorghum flour without soaking treatment was 70.90%, while brown sorghum flour with soaking reached 76.92%, so the energy produced ranged between 320-360 kcal.

Crude sorghum fibers are concentrated in the pericarp, which consists of cellulose, hemicellulose, and a little lignin [7,12]. The crude fiber content of red and white sorghum flour with and without Na_2CO_3 soaking treatment ranged from 3.54% to 8.52% [30]. The results of the analysis showed that the levels of sorghum (brown and white) crude fiber were classified as high and highest compared to reference sorghum and other cereals, i.e., 10.31% (brown sorghum) and 9.03% (white sorghum). The high levels of the crude fiber of sorghum grain are due to not being milled. Sorghum crude fiber content reference that has been through the process of polishing ranges from 2 to 5.18%.

3.1.4. Starch (Amylose and Amylopectin)

The main carbohydrates stored in food are called starch. Starch levels in sorghum grains range from 50- 70% [8]. According to [7,8], large sorghum grains have high starch content and otherwise. Starch is composed of amylose and amylopectin. Amylopectin has a larger granule size and lower viscosity than amylose. The ratio of amylose and amylopectin in starch will affect the solubility and degree of gelatinization. Low amylose levels cause a thicker solution, while high amylopectin levels cause soft texture and good taste. Three types of starch are 1) normal (amylose:amylopectin = 17-21%:79-83%), 2) waxy (1-0%:99-100%), 3) high amylose (>70%:<30 %)[8]. The analysis showed that sorghum (brown and white) belonged to the type of waxy sorghum with amylose: amylopectin ratio of 2.94-3.93%:56.72- 59.79%.

Table 2. Composition of sorghum starch

Type of Cereal	Amylum (%)	Amylose (%)	Amylopectin (%)
Brown Sorghum* (b/b)	60.65	3.93	56.72
White Sorghum* (b/b)	62.73	2.94	59.79

3.2. The effect of polishing on the nutrition of sorghum crackers

The potential nutrient content in sorghum is carbohydrate and protein. This nutrient can decrease during improper sorghum processing. The tannin compounds (anti-nutrition substances) in the sorghum pericarp affect the nutritional content of processed products. Tannin compounds have been known to reduce nutrient content, digestibility of proteins and starches, and the taste of processed products. According to [31] that the sorghum removal process for 5 minutes, followed by immersion treatment in Na2CO3 solution of 0.3% for 24 hours, was able to reduce tannin compounds by 77.46%. In this study, the results of the influence of polishing and sorghum on the nutritional content of processed products, namely sorghum crackers (raw) (Table 3).

Table 3. The nutritional content of sorghum crackers

Type of crackers	Water (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre (%)	Carbohydrate (%)	Energy (kcal)	β-Caroten (mg/100g)
A0	12.59	5.15	4.85	2.13	5.96	69.33	306.86	91.14
A1	12.54	2.78	5.71	5.28	5.69	67.99	333.92	2134.16
B0	13.66	2.39	7.48	1.46	6.45	68.56	309.10	23.98
B1	12.11	2.66	7.74	1.28	5.41	70.81	317.23	53.01

Note: A0 = Brown sorghum crackers without polishing; A1 = Brown sorghum crackers with polishing; B0 = White sorghum crackers without polishing; B1 = White sorghum crackers with the polishing

3.2.1. Water and Ash Content

Water content is a physical characteristic that measures the amount of water contained in a material. The results showed that the water content of sorghum crackers was relatively the same as the water content when it was still a sorghum grain. The moisture content of sorghum crackers is high because the value is above the specified quality requirements, both crackers originating from fish (SNI 01-2713.1: 2009), shrimp (SNI 2714.1: 2009), and raw rice (SNI 01- 4307-1996), which is a maximum of 12%. High and low levels of water crackers are influenced by drying techniques (temperature, duration, and moisture content of raw materials) and types of packaging [32,33].

Quality requirements stipulate that the ash content for cracker products is a maximum of 1% (insoluble in acids). The results showed that the ash content of the four sorghum cracker treatments reached more than 1% (Table 3.). This is due to differences in analysis techniques. The ash content analysis in this study used an analysis of total ash content (it did not differentiate between the levels of ash dissolved and insoluble in acids). However, of the four treatments, the highest levels of ashes were crackers derived from brown sorghum seeds without polishing (5.15%). The results of the study illustrate that the high and low levels of sorghum cracker ash are more dominantly influenced by the type of sorghum compared to the polishing treatment. Colored sorghum has a higher ash content than white sorghum. This is consistent with the analysis of ash content while still in the form of dry sorghum grain (Table 1.).

3.2.2. Protein and Fat

Protein is one of the sorghum-based superior nutrients. Protein is produced by animal and vegetable products. Animal-based crackers (shrimp and fish) have a minimum protein quality requirement of 5% [34]. Measurement of sorghum cracker protein levels refers to animal-based protein cracker levels. The results showed that the protein content that could not meet the quality requirements for crackers was sorghum crackers made from brown sorghum grain and without polishing (Table 3.). This study illustrates that the type of sorghum and the treatment of polishing affect the protein content of cracker products. The protein content of sorghum grain is directly proportional to the processed product, while the treatment of polishing can increase the protein content of the processed product. This is because the process of polishing will release the layer of pericarp and sorghum grain testa, [35] where the layer contains anti-nutrient compounds (tannins) [36]. Reduced levels of tannin in sorghum grain will increase nutrient levels, including protein levels [31].

Fat is not the primary nutrient required in cracker products, so there is no standard value. The fat content of white sorghum grain-based crackers both with and without polishing decreased, while the brown sorghum grain-based crackers both with and without polishing increased. This shows that there is no influence of sorghum type and polishing treatment on its processed products. Research [6,11,12] states that the largest percentage of sorghum grain fat content lies in the germ (80% of total fat) and aleuron layer. This is reinforced by the opinion that polishing only releases the layer of pericarp and testa [37] so that the fat content in the germ is not exposed to polishing. Increased levels of fat in sorghum-based cracker products are more influenced by the supporting ingredients added to sorghum crackers.

3.2.3. Carbohydrate, Energy, and Crude fiber

Carbohydrates, as the largest nutritional component of sorghum commodities, indicate that the processed products produced (sorghum crackers) have increased carbohydrate levels by 3-7%. This is more influenced by the supporting material added. The increase in carbohydrate levels is consistent with the value of the energy produced. The type of sorghum and treatment of polishing did not affect carbohydrate nutrition.

The crude fiber in sorghum crackers is degraded. The most considerable crude fiber content lies in the sorghum grain coat [11] so that theoretically, the treatment of the polishing affects the levels of crude fiber processed products. However, the results of the study showed that a decrease in the ranks of crude fiber occurred in all sorghum cracker products, both treated and without treated. This level of decline in crude fiber content distinguishes between those subjected to polishing and those not. Polishing reduces crude fiber levels more significantly than those that do not, although not significantly.

3.2.4. β-Carotene

β-Carotene is a micro compound in sorghum grain. But its availability in food products provides functional benefits for body health, such as eyes, immune function, and growth [38]. Research by [39] reported that high levels of unsaturation caused pro vitamin A carotenoids to be unstable when exposed to heat, exposure to light, and oxygen during cooking and storage. Oxidation is a significant factor in driving decreased levels of *β-carotene* [40]. The results showed that crackers made from brown sorghum grain had a higher *β-carotene* content than white sorghum grain (Table 3.). This is in line with the opinion of [41], who reported that sorghum grain with brown pericarp has higher levels of *β-carotene* than sorghum grain with white pericarp. It was also known that the treatment of polishing would increase the value of *β-carotene*, which proves directly that the content of anti-nutrient compounds (tannins) in the layer of pericarp and sorghum grain testa significantly inhibited the useful content of sorghum grain. The removal of these layers (pericarp and testa) increases the nutritional value of the processed products.

4. Conclusion

We conclude that polishing on different sorghum types (brown and white) affects the nutritional content of the sorghum crackers. We found that the sorghum grain polishing process increased the nutritional content (protein and β carotene) of sorghum crackers. Polishing on white sorghum grain will produce high protein sorghum crackers while polishing brown sorghum grain will make sorghum crackers with high β carotene content.

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Presentation Slides

THE EFFECT OF THE POLISHING PROCESS AND SORGUM TYPE (BROWN AND WHITE) ON THE CONTENT OF CRACKERS NUTRITION

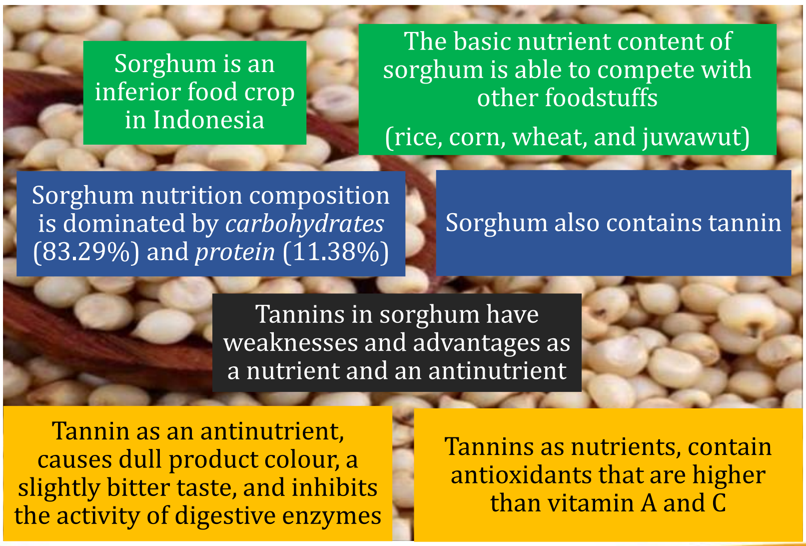
***Retno* Utami Hatmi[1]*, *Arya* Wirabhuana[2], *Yeyen* Prestyaning Wanita[1], *Edi* Tando[3] dan *Musyadik*[3]**

[1]Assessment Institute for Agricultural Technology Yogyakarta

[2]UIN Sunan Kalijaga Yogyakarta

[3]Assessment Institute for Agricultural Technology Sulawesi Tenggara

Introduction



Sorghum is an inferior food crop in Indonesia

The basic nutrient content of sorghum is able to compete with other foodstuffs

(rice, corn, wheat, and juwawut)

Sorghum nutrition composition is dominated by *carbohydrates* (83.29%) and *protein* (11.38%)

Sorghum also contains tannin

Tannins in sorghum have weaknesses and advantages as a nutrient and an antinutrient

Tannin as an antinutrient, causes dull product colour, a slightly bitter taste, and inhibits the activity of digestive enzymes

Tannins as nutrients, contain antioxidants that are higher than vitamin A and C

Introduction

Tannins are polyphenol compounds found in the outer skin layers of sorghum (pericarp)

The colour of sorghum grains cannot be a reference to high and low content of tannins

The polishing can reduce tannin content up to 75%, with initial content of 1.82 - 3.98% to 0.36-1.72% depending on the type of variety

At this time sorghum products still play a role as a source of carbohydrat, this research leads to the processing of sorghum products by paying attention to basic nutrients (proximate) and functional nutrients (β carotene)

The purpose of this study was to determine the effect of polishing and type of sorghum (brown and white) on the nutrition content of sorghum crackers.

Methode

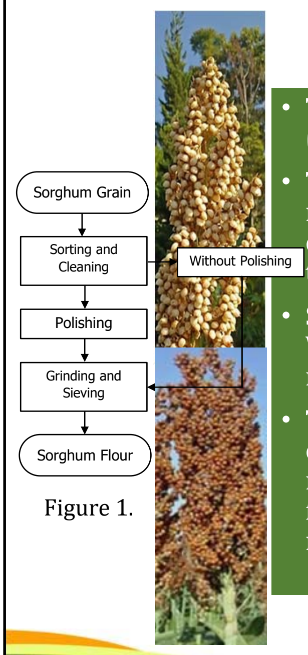


Figure 1.

- The raw material in the study was grain sorghum (brown and white)
- This study uses experimental design is completely randomized design (CRD) with 2 factors, 1) the type of grain sorghum (brown and white) and 2) polishing treatment (polishing and without polishing)
- Sorghum flour prepared according to the method Wulandari, E. (2018) and Mukkun, L. (2017) were modified (Figure 1).
- The abrasive polishing of sorghum grain was carried out for 2 minutes (Wardanu, 2016), using a rice mill machine. Then, the sorghum grain are grinded into flour. The sorghum flour is sieved using a size of 60 mesh, and ready to be used for making crackers

Methode

- The nutritional parameters of sorghum grain and processed products (sorghum crackers) that were analyzed included proximate (water content, ash content, protein, fat, crude fiber), starch (amylose and amylopectin) (AOAC, 1975), carbohydrates (by difference Nielsen 1998) and energy (bomb calorimeter). Especially for processed products (sorghum crackers), the nutritional parameters analyzed were supplemented with beta carotene content (spectrophotometry with a wavelength of 451 nm) (Blessin, C.W., 1962).

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Result and Discussion

Table 1. The basic nutritional content of several types of cereals

Type of Cereal	Water	Ash	Protein	Fat	Crude fibre	Carbohydrate	Energy
	(%)	(%)	(%)	(%)	(%)	(%)	(kcal)
Brown Sorghum* (b/b)	14,71	1,64	8,93	1,53	10,31	62,87	294,07
White Sorghum* (b/b)	13,29	1,62	8,58	1,82	9,03	65,65	305,90
Sorghum[1]	12,00	1,60	10,40	3,10	2,00	70,70	329,00
Sorghum[2]	10,60	2,80	10,38	2,80	5,18	73,39	-
Brown rice[1]	12,00	1,30	7,90	2,70	1,00	76,00	362,00
Corn[1]	12,00	1,20	9,20	4,60	2,80	73,00	358,00
Wheat[1]	12,00	1,60	11,6	2,00	2,00	71,00	342,00
Millet[1]	12,00	2,60	7,7	1,50	3,60	72,60	336,00

3.1 The nutriotion of sorghum grain

WATER CONTENT

- Sorghum nutrition in general does not differ greatly from other types of cereals
- The water content of sorghum grain (brown and white) is still quite high (13.29% and 14.71%) compared to others
- Drying sorghum grain is done 2 times before (12-14%) and after threshing (max 12%) (Firmansyah, 2013)

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Result and Discussion

ASH CONTENT

- Sorghum grain ash content (brown and white) is in accordance with reference (1.2% - 2.2%)

PROTEIN

- Protein in sorghum is the second largest nutritional component, which consists of prolamin / kafirin, albumin, globulin, and glutelin
- There are variations in sorghum protein content ranging from 8.58% to 10.40%, meanwhile, according to reference between 7.39% -9.86%
- Variation in protein content and composition is strongly influenced by genotype factors, water availability, temperature, soil fertility and environmental conditions during the growth of sorghum grain (Léder, 2004)

Result and Discussion

FAT

- The fat content in sorghum grain is relatively low compared to other food ingredients, but relatively comparable to other types of cereals
- Sorghum fatty acids are dominated by unsaturated fatty acids that are beneficial for health (linoleic acid (49%), oleic acid (31%)) (Léder, 2004)

CARBOHYDRATE

- These results are consistent with reference, that sorghum carbohydrate content is relatively lower compared to other cereals (62.87 to 65.65%)

CRUDE FIBER

- The analysis showed that the content of sorghum crude fiber were classified as high compared to reference, this is due to not being polished.
- According reference that sorghum crude fiber content that has been through the process of polishing ranges from 2 to 5.18%.

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Result and Discussion

Table 2. Composition of sorghum starch

Type of Sorghum	Amilum (%)	Amylosa (%)	Amylopectin (%)
Brown Sorghum* (b/b)	60,65	3,93	56,72
white Sorghum* (b/b)	62,73	2,94	59,79

Starch (Amylose and Amylopectin)

- Starch content in sorghum grains range from 50-70% (Liu, 2009 *in* Sukarminah, 2015)
- The ratio of amylose and amylopectin in a starch will affect the solubility and degree of gelatinization. Low amylose content cause a thicker solution, while high amylopectin content cause soft texture and good taste
- The analysis showed that sorghum (brown and white) belonged to the type of waxy sorghum

Result and Discussion

3.2 The effect polishing to nutriotion of sorghum crackers

Table 3. The nutrition content of several types of sorghum crackers (raw)

Type of Crackers	Water (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre (%)	Carbohydrate (%)	Energy (kcal)	β-Caroten
A0	12,59	5,15	4,85	2,13	5,96	69,33	306,86	91,14
A1	12,54	2,78	5,71	5,28	5,69	67,99	333,92	2134,16
B0	13,66	2,39	7,48	1,46	6,45	68,56	309,10	23,98
B1	12,11	2,66	7,74	1,28	5,41	70,81	317,23	53,01

Note : A0 = Brown sorghum crackers without polishing
A1 = Brown sorghum crackers with polishing
B0 = White sorghum crackers without polishing
B1 = White sorghum crackers with polishing

Result and Discussion

WATER CONTENT

- Water content of sorghum crackers is high, because the value is above the specified quality requirements, both crackers originating from fish (SNI 01-2713.1: 2009) (BSN, 2009), shrimp (SNI 2714.1: 2009), and raw rice (SNI 01- 4307-1996), which is a maximum of 12%.
- High and low content of water crackers are influenced by drying techniques (temperature, duration, and moisture content of raw materials) and types of packaging (Syafriyudin and Purwanto, 2009; Sunyoto, *et al.*, 2017).

Type of Crackers	Water (%)
A0	12,59
A1	12,54
B0	13,66
B1	12,11

Note : A0 = Brown sorghum crackers without polishing
A1 = Brown sorghum crackers with polishing
B0 = White sorghum crackers without polishing
B1 = White sorghum crackers with polishing


Result and Discussion

ASH CONTENT

- The results showed that the ash content of the four sorghum cracker treatments reached more than 1%.
- The results of the study illustrate that the high and low content of sorghum cracker ash are more dominantly influenced by the type of sorghum compared to the polishing treatment

Type of Crackers	Ash (%)
A0	5,15
A1	2,78
B0	2,39
B1	2,66

Note : A0 = Brown sorghum crackers without polishing
A1 = Brown sorghum crackers with polishing
B0 = White sorghum crackers without polishing
B1 = White sorghum crackers with polishing


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Result and Discussion

PROTEIN

- Measurement of sorghum cracker protein content refers to animal-based protein cracker.
- The results showed that sorghum crackers made from brown sorghum grain and without polishing could not meet the quality requirements for crackers (Table 3.).
- This study illustrates that the type of sorghum and the treatment of polishing affect the protein content of cracker products.
- This happens because the polishing treatment will release the layer of pericarp and sorghum grain testa (Rooney and Miller, 1982 in Pangaribuan, et al., 2016) where that layer contains anti-nutrient compounds (tannins).
- The reduced content of tannins in sorghum grain will increase nutritional content including protein (Amrinola, *et al*., 2015)

Type of Crackers	Protein (%)
A0	4,85
A1	5,71
B0	7,48
B1	7,74

Note : A0 = Brown sorghum crackers without polishing
A1 = Brown sorghum crackers with polishing
B0 = White sorghum crackers without polishing
B1 = White sorghum crackers with polishing

Result and Discussion

FAT

- The analysis show that there is no influence of sorghum type and polishing treatment on its processed products.
- Research Hubbard, *et al.* (1968) *in* Suarni and Firmansyah (2013) and Rooney and Saldivar (1991) *in* Kulamarva *et al.* (2009) stated that the largest fat content of sorghum grain was in the germ (80% of the total fat) and the aleurone layer, so that the polishing treatment did not affect the fat content.

Type of Crackers	Fat (%)
A0	2,13
A1	5,28
B0	1,46
B1	1,28

Note : A0 = Brown sorghum crackers without polishing
A1 = Brown sorghum crackers with polishing
B0 = White sorghum crackers without polishing
B1 = White sorghum crackers with polishing

Result and Discussion

CRUDE FIBER

- Crude fiber in all sorghum crackers were degraded
- The largest crude fiber content was in the sorghum grain layer (Hubbard, *et al.*, 1968 *in* Suarni and Firmansyah, 2013), so that theoretically the polishing treatment affects the content of crude fiber processed products.
- The amount of reduction in crude fiber content is what distinguishes between polished and unpolished treatments

Type of Crackers	Crude fibre (%)
A0	5,96
A1	5,69
B0	6,45
B1	5,41

Note : A0 = Brown sorghum crackers without polishing
A1 = Brown sorghum crackers with polishing
B0 = White sorghum crackers without polishing
B1 = White sorghum crackers with polishing

Result and Discussion

CARBOHYDRATE

- The analysis showed that the processed product (sorghum crackers) had an increase in carbohydrate content by 3-7%. This is more influenced by the added support materials.
- The type of sorghum and treatment of polishing did not affect the carbohydrate nutrition.

Type of Crackers	Carbohydrate (%)
A0	69,33
A1	67,99
B0	68,56
B1	70,81

Note : A0 = Brown sorghum crackers without polishing
A1 = Brown sorghum crackers with polishing
B0 = White sorghum crackers without polishing
B1 = White sorghum crackers with polishing

Result and Discussion

β CAROTEN

- *β-Carotene* is a micro compound in sorghum grain
- Its availability in food products provides functional benefits for body health
- The results showed that crackers made from brown sorghum grain had a higher *β-carotene* content than white sorghum grain
- This is in line with the opinion of Shen, Yanting (2016) who reported that sorghum grain with brown pericarp have higher levels of *β-carotene* than sorghum grain with white pericarp.
- It was also known that the treatment of polishing would increase the value of *β-carotene*, which proves directly that the content of antinutrient compounds (tannins) in the layer of pericarp and sorghum grain testa significantly inhibited the functional content of sorghum grain.
- The removal of these layers (periscarp and testa) increases the nutritional value of the processed products

SUMMARY

- The water content of sorghum crackers has not met the SNI requirements, so it is necessary to study time, drying, packaging and storage techniques to achieve the water content quality standard.
- The polishing treatment had a greater effect on reducing the ash content of brown sorghum crackers compared to white sorghum crackers.
- The protein content of sorghum crackers is relatively high and meets Indonesian Standards National (SNI) for crackers.
- In processed products (sorghum crackers), the polishing treatment of sorghum grain has an effect on increasing protein and beta carotene content but decreasing crude fiber content.
- White sorghum grain with polishing treatment will produce high protein crackers, while brown sorghum grain with polishing treatment will produce high beta carotene crackers.

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TERIMA KASIH

Certificate

CERTIFICATE OF PARTICIPATION

No: 3980/UN25/TU/2020

This is to certify that

Arya Wirabhuana, S.T, M.Sc

has attended as oral presenter following paper entitled:

The effect of the polishing process and sorgum type (brown and white) on the content of crackers nutrition

at the 4th International Conference on Agriculture and Life Sciences "Retouching Strategy for Exploring Potency of Industrial Crops for Health in Adapting to The New Normal Era" held at University of Jember, East Java, Indonesia October 6-7, 2020

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Dr. Ir. Iwan Taruna, M.Eng
NIP 196910051994021001

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Wahyu Indra Duwi Fanata, SP., M.Sc., Ph.D
NIP 198102042015041001