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The Effect of Drying Temperature and Time on the Chemical and Functional Characteristics of Couple Bean Surrounding Flour (Vigna unguiculata)

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Abstract

Cowpea has a high protein value but contains anti-nutritional substances so the germination process is required. Cowpea sprouts can be processed into flour which is then used as raw material for various processed food products such as instant porridge. This study aimed to examine the chemical and physical characteristics of cowpea sprouted flour due to temperature treatment and drying time. This study used a completely randomized design with a factorial pattern with two treatment factors, namely temperature consisting of 3 levels (50oC, 60oC, and 70°C) and drying time factor consisting of 12, 14, and 16 hours. The data obtained were analyzed using variance if it had a significant effect ($P<0.05$) followed by the Least Significant Difference (LSD) test. The results showed that the temperature treatment of 70oC and drying time of 16 hours was the best treatment which produced cowpea sprouts flour with a water content of 2.51%, ash content of 4.93%, the protein content of 24.52%, a fat content of 2.34%, the content of carbohydrates 65.71%, crude fiber content 9.36%, wettability 178.76 seconds, Kamba density 0.43 g/ml, water absorption index 1.73 mlH2O/g, solubility index 40.60% and color (L) 80.47.

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1 Introduction

Cowpea (Vigna unguiculata) has a protein content ranging from 18.3%-25.53% depending on the age of cowpea seeds. The advantage of cowpea is that it has a low-fat content so it can minimize the negative effects of using fatty food products (Rosida et al., 2013). Cowpeas also have anti-nutritional compounds such as anti-trypsin, lectins, and phytic acid which can reduce the bioavailability of the nutrient content in cowpeas. eliminate these anti-nutrients, namely by germination. Germination is an effective technology for improving the quality of legumes, besides the germination process does not require expensive costs. Germination has been shown to increase the nutritional content, digestibility, and availability of free amino acids, dietary fiber, and bioactive components of lupine nuts (Lupinusangustifolius L.). Germination can also cause changes in the functional properties of the chemical composition and the content of anti-nutritional substances such as anti-trypsin in gude beans (Wisaniyasa et al., 2015).

The germination process was also proven to be able to increase the levels of soluble dietary fiber and antioxidant activity in the manufacture of sprouted chickpea (Lablab purpureus (L.) Sweet). Knowledge of fiber is interesting because of its physiological effects, various studies have linked soluble dietary fiber and antioxidants with hypercholesterolemia (Wisaniyasa & Suter., 2016). According to Wisaniyasa et al. (2017), Gude bean germination for 48 hours was able to reduce the activity of antitrypsin (trypsin inhibitor) by 36%. The study also proved that germination can improve the nutritional quality of seeds. The germination treatment can also change some components of protein and fatty acids so that the biological value of the sprouts will increase and the digestibility will be higher because of the process of breaking down complex molecules into simpler molecules.

The utilization of cowpea sprouts is still limited so the processing that can be done is by flouring. Flour technology was chosen because it has several advantages, namely easier handling in processing and storage and ensuring the safety of raw materials. One of the important steps in flour processing is drying. This drying process is carried out to facilitate the grinding or crushing process and the sieving process. Drying is a method for removing or removing water from the material by evaporating the water using heat energy. Usually, the water content of the material is reduced to a certain extent so that microorganisms can no longer grow in it. According to Winarno, the drying method generally uses heat, so it has several disadvantages, namely because the original nature of the dried material can change such as physical changes (color and shape), chemical properties, and nutrient content so that the quality decreases. Drying of foodstuffs aims to extend the shelf life. Drying can take place properly if heating occurs in every place of the material, and water vapor is taken from all surfaces of the material (Winarno, 1993).

According to Lisa et al. (2015), drying at a temperature of 65oC with a drying time of 5.5 hours produces the best white oyster mushroom flour where the yield is 7.43%, water content is 4.30%, ash content is 4.75 % and protein content as much as 19.20%. Drying with a temperature of 50oC and a drying time of 8 hours produces the best taro tuber flour where the yield is 8.57%, water content is 11.80%, ash content is 11.46%, protein content is 5.95%, and carbohydrate content as much as 73.58% (Erni et al., 2018). Drying is an easy method of food preservation that aims to reduce the water content in the material so that it can inhibit microbial growth and unwanted reactions. Several factors that influence the success of drying are drying temperature and drying time. Drying temperature affects the quality of the product because a temperature that is too low will cause failure in drying which results in temporary material spoilage.

According to Prasetyaningsih & Billah (2019), drying agricultural products using a good drying air flow is between 45oC-75oC. Drying at temperatures below 45oC is not recommended because microbes and fungi that damage the product are still alive, resulting in low shelf life and product quality. However, the drying air temperature above 75oC causes the chemical and physical structure of the product to be damaged due to heat and water mass transfer which results in changes in cell structure. Drying time also affects the quality of food products because the longer the drying time, the longer the heat contact with the ingredients which results in the evaporation of water in the ingredients very quickly so that the water in the ingredients decreases and affects the protein in the ingredients (Martunis, 2012). Therefore, it is necessary to do the right drying temperature for cowpea sprouted flour.

2 Materials and Methods

This research was conducted in the Food Processing Laboratory, Food Analysis Laboratory, Process Engineering Laboratory, and the Biochemistry and Nutrition Laboratory, Faculty of Agricultural Technology, Udayana University, which will last for 6 months from December 2020 to May 2021. This research consisted of 2 (two) stages, namely the first stage, making cowpea sprout flour, and the second stage, application of cowpea sprout flour with a ratio of brown rice flour in making instant porridge. Phase I research is the stage of making cowpea sprout flour. Fresh cowpeas are sorted by selecting seeds that are whole and undamaged. Washed and soaked in clean water with a ratio of peanuts: water (1:4) for 12 hours, then the cowpea seeds were drained and then placed in a container that had been lined with banana leaves to germinate, the germination process was carried out for 48 hours and every 12 hours sprayed with water. as much as 10 ml per 250 g of modified cowpeas (Febrianti et al., 2014). Cowpeas that have been germinated for 48 hours are then steam blanched at 60ºC for 5 minutes. The cowpea sprouts were then placed on a baking sheet and then dried in an oven at a temperature of 50oC, 60oC, and 70oC with a drying time of 8, 12, and 16 hours, then blended and sieved through a modified 60 mesh sieve (Ismayanti & Harijono, 2015). The best results in the first stage will then be used for research in the second stage, namely the manufacture of instant porridge.

The study was conducted using a completely randomized design (CRD) with a factorial pattern with two treatment factors and 2 replications. Factor 1 is the drying temperature which consists of 3 levels, namely: 50oC, 60oC, and 70oC. Factor 2 is drying time which consists of 3 levels, namely: 12, 14, and 16 hours. The treatments obtained were 9 treatment combinations. Each treatment was repeated 2 times to obtain 18 experimental units. Variables observed in the study included analysis of moisture content, ash content, protein content, fat content, carbohydrate content, crude fiber content Sudarmadji et al. (1997), functional properties: wettability of Bhandari flour, (2000), density of Kamba, the water absorption index of the volumetric method of Senanayake et al. (2013), the solubility index of the gravimetric method of Senanayake et al. (2013), and the color intensity (L) according to Weaver (1996). The data obtained were analyzed by means of variance and if the treatment had an effect on the observed variables, it was continued with the Least Significant Difference (LSD) test and determining the best treatment using the effectiveness test method.

3 Results and Discussions

Water content

The results of the variance showed that the interaction of temperature and drying time had a very significant effect ($P<0.01$) on the moisture content of cowpea sprout flour (Santosa & Yusuf, 2017; Saravanadurai & Manimehalai, 2016; Warrag & Hall, 1984). The results of the analysis of the moisture content of cowpea sprout flour on temperature treatment and drying time can be seen in Table 1. The highest moisture content of cowpea sprout flour was obtained from the 50oC drying temperature treatment with a drying time of 12 hours, which was 5.99% which was significantly different from other treatments. The lowest water content was treated with a drying temperature of 70oC with a drying time of 16 hours, which was 2.51%.

Table 1
The results of the analysis of the moisture content of cowpea sprout flour

Treatment	Drying time (hours)		
	12	14	16
Drying Temperature 50°C	5.99 a (a)	4.67 b (a)	4.39 b (a)
Drying Temperature 60°C	3.57 a (b)	3.17 a (b)	3.05 a (b)
Drying Temperature 70°C	2.96 a (c)	2.70 a (b)	2.51 a (c)

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

The lowest water content of cowpea sprouted flour was caused by the loss of water content in the drying process. The longer drying process causes the evaporation of water contained in the cowpea sprout flour to be higher so that the water content contained in the cowpea sprout flour becomes lower. Reducing the moisture content of cowpea sprouts flour is very necessary, the water content can affect the flour storage process. Taufiq (2004), states that the greater the drying temperature, the drying rate will increase. This is because the higher the temperature of the drying air, the higher the heat energy carried by air, so the greater the amount of liquid mass that is evaporated from the surface of the material. This shows that the longer the drying time, the less water content in the material (Sudarmadji et al., 1997).

Ash content

The results of the variance showed that the interaction of temperature and drying time had no significant effect (P>0.05) on the ash content of cowpea sprouts flour. The results of the analysis of the ash content of cowpea sprout flour can be seen in Table 2.

Table 2
The results of the analysis of the ash content of cowpea sprout flour

Temperature	Drying time (hours)						
	12		14		16		Average	
50°C	4.79		5.21		4.98		4.99	a
60°C	4.65		4.55		4.88		4.69	a
70°C	5.11		5.01		4.93		5.02	a
Average	4.85	a	4.92	a	4.93	a		

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

The results of the analysis of the ash content of cowpea sprouts flour showed that the treatment temperature and drying time did not significantly affect the ash content of cowpea sprouts flour in all treatments. The results of the analysis of the highest ash content of cowpea sprouts flour at a temperature of 50ºC with a drying time of 14 hours are 5.21% and the lowest ash content is at a temperature of 60ºC with a drying time of 14 hours, which is 4.55%. The ash content contained in a material indicates the number of minerals contained in the material, the higher the ash content the higher the mineral content. According to Anita (2009), nuts are a good source of minerals. Ash content is a parameter to show the value of inorganic (mineral) content in a material or product. Sudarmaji et al. (1997), stated that the inorganic components in a material vary greatly in both type and amount. The content of inorganic materials contained in a material include calcium, potassium, phosphorus, iron, and magnesium. The drying process results in the decomposition of the bonded components of water molecules (H_2O) and also increases the sugar, fat, and mineral content (Siddhuraju, & Becker, 2007; Xu et al., 2019; Uriyo, 2001).

Protein content

The results of the variance showed that the interaction of temperature and drying time had a significant effect (P<0.05) on the protein content of cowpea sprouts flour. The results of the analysis of protein content of cowpea sprouts flour on temperature treatment and drying time can be seen in Table 3.

Table 3
Results of analysis of protein content of cowpea sprout flour

Treatment	Drying time (hours)		
	12	14	16
Drying Temperature 50°C	28.20 a (a)	27.97 a (a)	27.37 b (a)
Drying Temperature 60°C	27.55 a (b)	26.49 b (b)	25.33 c (b)
Drying Temperature 70°C	24.55 a (c)	24.11 a (c)	24.52 a (c)

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

The results of the analysis of protein content of the highest cowpea sprouts flour at 50ºC temperature treatment with 12 hours drying time is equal to 28.80% and not significantly different from 50ºC temperature treatment with 14 drying time that is 27.97% but significantly different from other treatments. The lowest protein content was treated at 70ºC with a drying time of 14 hours, which was 24.11%. The increasing temperature and drying time caused a decrease in the protein content of cowpea sprouts flour. This is due to the process of protein denaturation (Lisa et al., 2015). This is supported by the research of Nur et al. (2018), where the protein content of cowpea flour decreased with the long drying treatment.

Fat level

The results of the variance showed that the interaction of temperature and drying time had no significant effect (P>0.05) on the fat content of cowpea sprouts flour. The results of the analysis of fat content of cowpea sprouts flour on temperature treatment and drying time can be seen in Table 4.

Table 4
The results of the analysis of the fat content of cowpea sprout flour

Temperature	Drying time (hours)							
	12		14		16		Average	
50°C	2.74		2.51		2.46		2,57	a
60°C	2.89		2.60		2.51		2.67	a
70°C	2.62		2.47		2.34		2.48	A
Average	2.75	a	2.53	a	2.44	a		

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

The results of the analysis of the highest fat content of cowpea sprouts were treated with a drying temperature of 60ºC with a drying time of 12 hours, which was 2.89% and the lowest fat content was obtained at a drying temperature of 70ºC with a drying time of 16 hours, which was 2.34%. The results of the analysis of fat content in cowpea sprouted flour decreased with increasing drying time. This is because the heating process causes the breakdown of the fat components in the material. The germination process can also reduce the fat content in cowpea sprouted flour. This is because the germination process causes a breakdown of fat which is converted into energy (Mubarak, 2005). This is supported by the research of Wisaniyasa & Suter (2016), which stated that there was a decrease in fat content in red bean sprout flour by 0.38% where the fat content of red bean sprout flour was 6.22% compared to 6.60% red bean flour. Hazmi's (2016), research stated that there was a decrease in fat content in soybean sprout flour by 15.29% whereas the fat content of soybean sprout flour was 23.36% compared to 38.65% soybean flour.

Carbohydrate content

The results of the variance showed that the interaction of temperature and drying time had a very significant effect (P<0.01) on the carbohydrate content of cowpea sprouts flour. The results of the analysis of carbohydrate content of cowpea sprout flour on temperature treatment and drying time can be seen in Table 5. The results of the analysis of the highest carbohydrate content of cowpea sprouts flour at a drying temperature of 70ºC with a drying time of 16 hours is equal to 65.71% and not significantly different from the treatment at a temperature of 70ºC with a drying time of 12 and 14 hours that is equal to 64.76% and 65.71 % but significantly different from other treatments (Uwaegbute et al., 2000; Kirigia et al., 2018; Larcher et al., 1990). The results of the lowest carbohydrate content at 50ºC drying temperature treatment with a drying time of 12 hours is equal to 58.27%. The longer the drying time on the material causes the carbohydrate content in cowpea sprout flour to increase. Carbohydrate content using calculation by difference is influenced by water content, ash content, fat content, and protein content. This is in accordance with the statement of Fatkurahman et al. (2012), that carbohydrate content calculated by difference is influenced by other nutritional components, namely protein, fat, water, and ash. This is in line with the statement of Sulistiyono (2014), that the heating process of foodstuffs can increase the availability of carbohydrates due to the swelling of starch granule molecules. Swelling of starch granules by water causes the molecular weight of starch to increase, resulting in an increase in the total carbohydrate content. This is in accordance with research by Akbar et al. (2019), that the higher the heating temperature, the higher the concentration of gelatinized starch.

Table 5
Results of analysis of carbohydrate content of cowpea sprout flour

Treatment	Drying time (hours)			Dng time (hours)
	12	14	16	
Drying Temperature 50°C	58.27 c (c)	59.64 b (c)	60.79 a (c)	
Drying Temperature 60°C	61.34 c (b)	63.19 b (b)	64.24 a (b)	
Drying Temperature 70°C	64.76 b (a)	65.71 a (a)	65.71 a (a)	

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

According to Sundari (2015), heating for too long will cause a decrease in antinutrient compounds and the heating process can increase the availability of nutrients contained in the ingredients. Muchtadi & Ayustaningwarno (2010), stated that by reducing the water content, compounds such as carbohydrates, proteins and minerals increased. In line with Ranken (2000), that reduced water due to the heating process at high temperatures can cause an increase in the amount of carbohydrate content.

Crude Fiber Content

The results of the variance showed that the interaction of temperature and drying time had a very significant effect ($P<0.01$) on the crude fiber content of cowpea sprouts flour. The results of the analysis of crude fiber content of cowpea sprouts flour on temperature treatment and drying time can be seen in Table 6. The results of the analysis of the highest crude fiber content of cowpea sprouts flour at a drying temperature of 50ºC with a drying time of 14 hours, which is 9.80% and not significantly different from the treatment at 70ºC with a drying time of 16 hours, which is 9.36% but significantly different from the treatment. other. The results of the lowest crude fiber content at 50ºC drying temperature treatment with a drying time of 12 hours is equal to 7.42%. Crude fiber is a part of food that cannot be hydrolyzed by strong acids and strong bases.

Table 6
Results of analysis of crude fiber content of cowpea sprout flour

Treatment	Drying time (hours)		
	12	14	16
Drying Temperature 50°C	7.42 c (c)	9.80 a (a)	8.30 b (b)
Drying Temperature 60°C	8.19 b (a)	9.47 a (b)	8.05 b (b)
Drying Temperature 70°C	7.75 b (b)	9.08 a (c)	9.36 a (a)

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

Nuts are known to contain quite a lot of crude fiber. The long drying treatment causes the food fiber content of cowpea sprout flour to increase. This occurs because heat treatment causes a reduction in the nutritional content so that the crude fiber content is higher (Augustyn et al., 2017). According to research by Lintas & Cappeloni (1988), in Muchtadi (2001), which states that nuts are susceptible to loss of soluble components such as sugar, soluble protein, minerals, and pectate substances into water and resulting in a decrease in water content, so that will increase dietary fiber content. The decrease in water content is caused by starch granules that break due to long heating it affecting the amylose component and affecting the crude fiber content (Utama et al., 2019).

Wettability

The results of the variance showed that the interaction of temperature and drying time had a very significant effect ($P<0.01$) on the wettability of cowpea sprouts flour. The results of the wettability analysis of cowpea sprouts on temperature treatment and drying time can be seen in Table 7.

Table 7
Wettability results of cowpea sprouted flour

Treatment	Drying time (hours)			Drying time (hours)
	12	14	16	
Drying Temperature 50°C	341.18 a (a)	319.90 c (a)	324.31 b (a)	
Drying Temperature 60°C	166.00 a (b)	144.76 b (c)	166.81 a (c)	
Drying Temperature 70°C	161.45 c (c)	176.43 b (b)	179.76 a (b)	

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

The results of the analysis of the highest wettability of cowpea sprouts were treated with a drying temperature of 50ºC with a drying time of 12 hours, which was 341.18 seconds and was significantly different from other treatments. The lowest wettability results were treated with a drying temperature of 60ºC with a drying time of 14 hours, which was 144.75 seconds. Wettability is the time it takes flour to get wet or absorb water. Flour contains starch which when dried causes the water component to evaporate leaving a porous matrix and can easily reabsorb water. Foodstuffs that contain more water will have less porosity so that the diffusion of water that enters during the water absorption process will be slower (Amirullah., 2008). The finer the flour, there is no empty space left between the flour particles so the wet flour tends to take longer to wet the entire surface of the flour particles (Hartoyo & Sunandar, 2006).

Kamba Density

The results of the variance showed that the interaction of temperature and drying time had a very significant effect ($P<0.01$) on the density of cowpea sprouted kamba flour. The results of the analysis of the density of kamba cowpea sprouts on temperature treatment and drying time can be seen in Table 8. The results of the analysis of the highest density of kamba powder for cowpea sprouts were treated with a drying temperature of 60ºC with a drying time of 16 hours, which was 0.46 g/ml and significantly different from other treatments (Phillips et al., 1984; Ehlers & Hall, 1997; Prinyawiwatkul et al., 1997). The results of the lowest density of kamba were treated with a drying temperature of 50ºC with a drying time of 16 hours, which was 0.32 g/ml. Kamba density is one of the physical characteristics that is often used to plan the volume of processing equipment.

Table 8
The results of the Kamba density analysis of cowpea sprouted flour

Treatment	Drying time (hours)		
	12	14	16
Drying Temperature 50°C	0.34 a (c)	0.32 b (c)	0.32 b (c)
Drying Temperature 60°C	0.47 a (a)	0.45 c (a)	0.46 b (a)
Drying Temperature 70°C	0.39 b (b)	0.42 a (b)	0.43 a (b)

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

Kamba density is the ratio between the weight of the material and the volume of space occupied after the flour is compacted. The increase and decrease in the density of kamba in flour is influenced by the water content of flour. High water content causes flour particles to tend to stick together so that the volume of flour decreases and the flour becomes less sticky (Rahma et al., 2018). Ardhianditto et al. (2013), stated that the moisture content of the material is inversely proportional to the density value of the kamba, the higher the moisture content of the material, the lower the density value of the kamba. The greater the temperature difference between the heating medium and the food, the faster the heat transfers to the food and the faster the evaporation of water from the food, so that the density value of the kamba is greater. The density of kamba increases with decreasing water content in the material. According to Marousis & Saravacos (1990), bound water has a higher density than free water. The decrease in the amount of free water in the product increases and induces an increase in the density of the kamba. Kaya (2008), stated that the greater the density value of a flour, the smaller the storage space or packaging and transportation costs. The lower kamba density value indicates that at the same volume, the number of particles that occupy space in that volume is lighter than the higher kamba density.

Water Absorption Index

The results of the variance showed that the interaction of temperature and drying time had a very significant effect ($P<0.01$) on the water absorption index of cowpea sprouts flour. The results of the analysis of the water absorption index of cowpea sprouts flour on temperature treatment and drying time can be seen in Table 9. The results of the analysis of the highest water absorption index of cowpea sprouts were treated with a drying temperature of 60ºC with a drying time of 16 hours, namely 1.73 mlH_2O/g and not significantly different from the treatment at 70ºC with a drying time of 16 hours, but significantly different from other treatments. The results of the lowest water absorption index were treated with a drying temperature of 50ºC with a drying time of 12 hours, which was 0.49 mlH_2O/g.

Table 9
Results of analysis of water absorption index of cowpea sprout flour

Treatment	Drying time (hours)		
	12	14	16
Drying Temperature 50°C	0.49 b (c)	0.99 a (b)	0.99 a (b)
Drying Temperature 60°C	0.74 c (b)	0.99 b (b)	1.73 a (a)
Drying Temperature 70°C	0.99 c (a)	1.48 b (a)	1.73 a (a)

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

The water absorption index is influenced by the carbohydrate content, either starch or crude fiber, as well as protein and other hydrophilic components. At the same level of water addition, flour with high protein content has a greater water absorption index than flour with low protein content. The increase in the water absorption index of flour is caused by increasing the heating temperature related to the water content in flour, the lower the water content of flour, the higher the absorption index in flour (Sutrisno et al., 2018).

Solubility Index

The results of the variance showed that the interaction of temperature and drying time had a very significant effect ($P<0.01$) on the solubility index of cowpea sprouts flour. The results of the analysis of the solubility index of cowpea sprouts flour on temperature treatment and drying time can be seen in Table 10.

Table 10
The results of the analysis of the solubility index of cowpea sprouts flour

Treatment	Drying time (hours)		
	12	14	16
Drying Temperature 50°C	43.88 a	43.44 a	41.60 b
	(a)	(a)	(ab)
Drying Temperature 60°C	44.53 a	42.70 b	42.27 b
	(a)	(a)	(a)
Drying Temperature 70°C	40.46 a	40.47 a	40.60 a
	(b)	(b)	(b)

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

The results of the analysis of the highest solubility index of cowpea sprouts flour at a drying temperature of 60ºC with a drying time of 12 hours, which was 44.53% and not significantly different from the treatment at a temperature of 50ºC with a drying time of 12 hours, which was 43.88% but significantly different from other treatments. The results of the lowest solubility index at 70ºC drying temperature treatment with a drying time of 16 hours is equal to 40.60%. The solubility index is the ability of a substance to dissolve in a solvent. In this case, the solubility index is the ability of flour to dissolve in water. Based on the above results, the solubility index of cowpea sprouts flour increased with increasing heating temperature. This can be caused by starch in the material where the higher the blanching temperature, the starch will be hydrolyzed and changed from complex carbohydrates (polysaccharides) to carbohydrates or simple sugars that are more soluble in water (Sutrisno et al., 2018).

Color (L)

The results of the variance showed that the interaction of temperature and drying time had a very significant effect ($P<0.01$) on the fat content of cowpea sprouts flour. The results of the analysis of fat content of cowpea sprouts flour on temperature treatment and drying time can be seen in Table 11. The result of the color analysis (L) was the highest cowpea sprout flour at a drying temperature of 70ºC with a drying time of 12 hours, which was 82.30% and significantly different from other treatments. The lowest color yield (L) was at 50ºC drying temperature treatment with a drying time of 12 hours, which was 77.82 %. The higher the temperature used and the longer the drying time, the lower the brightness value or the darker it gets. The low brightness level is suspected to be a non-enzymatic reaction, namely the Maillard reaction. According to Winarno (1993), the Maillard reaction occurs when reducing sugars react with compounds that have NH_2 groups (proteins, amino acids, and peptides) and occurs when food is heated. In addition, reducing sugars undergo a caramelization reaction which is influenced by time and temperature during drying (Sudarmadji et al., 1997). Color is one of the aspects that first affects consumer acceptance of a product other than appearance. According to Eskin et al. (2011), stated that a dull or unsightly color will create a negative impression for consumers before judging other aspects. The color of the food material affects the appearance of the food material and the ability of the material to reflect, scatter, absorb or transmit visible light.

Table 11
Results of color analysis (L) of cowpea sprout flour

Treatment	Drying time (hours)		
	12	14	16
Drying Temperature 50°C	77.82 b (c)	81.85 a (a)	81.91 a (a)
Drying Temperature 60°C	80.62 b (b)	81.66 a (a)	81.81 a (a)
Drying Temperature 70°C	82.30 a (a)	80.78 b (b)	80.47 b (b)

Note: the same letter behind the average value in the same row or under the same column indicates no significant difference at the 5% LSD level.

Selection of the best treatment

The selection of the best treatment in the first phase of the study used the effectiveness test method. Based on the test results, the best treatment was obtained at a temperature of 70ºC with a drying time of 16 hours (T3W3) with the highest value of effectiveness of 0.66 which can be seen in Table 12. This shows that drying at a temperature of 70ºC and a drying time of 16 hours did not damage the components. chemical and physical powder of cowpea sprouts. According to Martinus (2012), the drying air temperature above 75ºC causes the chemical and physical structure of the product to be damaged due to heat and water mass transfer which has an impact on changes in cell structure. Characteristics of sprouted flour sometimes in arrears with a temperature treatment of 70ºC and a drying time of 16 hours complied with SNI 01-3751-2009. The results of the effectiveness test of cowpea sprouts flour can be seen in Table 12.

Table 12
Value of effectiveness test results cowpea sprout flour

Decision attribute	Analysis Result								
	Alternative Formula								
	T1W1	T1W2	T1W3	T2W1	T2W2	T2W3	T3W1	T3W2	T3W3
Water content	0.00	0.05	0.06	0,09	0.11	0.11	0.12	0.13	0.13
color	0.00	0.11	0.11	0,08	0.10	0.11	0.12	0.08	0.07
Solubility index	0.09	0.08	0.03	0,11	0.06	0.05	0.00	0.00	0.00
Water absorption index	0.00	0.04	0.04	0,02	0.04	0.11	0.04	0.09	0.11
Wettability	0.00	0.01	0.01	0,09	0.10	0.09	0.09	0.08	0.08
Kamba density	0.08	0.09	0.09	-0,01	0.01	0.00	0.04	0.02	0.02
Protein content	0.08	0.07	0.06	0,06	0.04	0.02	0.01	0.00	0.01
Carbohydrate content	0.00	0.01	0.03	0,03	0.05	0.06	0.07	0.08	0.08
Crude fiber content	0.00	0.08	0.03	0,03	0.07	0.02	0.01	0.05	0.06
Fat content	0.02	0.05	0.05	0,00	0.03	0.05	0.03	0.05	0.07
Ash content	0.01	0.04	0.03	0,01	0.00	0.02	0.03	0.03	0.02
Total	0.28	0.63	0.54	0,51	0.62	0.64	0.57	0.61	**0.66**

Note: T: Drying temperature, W: Drying time

4 Conclusion

1) Temperature and drying time has a very significant effect on moisture content, carbohydrate content, crude fiber content, wettability, the density of kamba, water absorption index, solubility index, color (L) and have a significant effect on protein content, fat content but have no significant effect on ash content of cowpea sprouts flour, 2) Temperature treatment of 70ºC and drying time of 16 hours is the best treatment that produces cowpea sprouts flour with 2.51% water content, 4.93% ash content, 24.52% protein content, 2.34% fat content, carbohydrate content 65.71%, crude fiber content 9.36%, wettability 178.76 seconds, the density of kamba 0.43 g/ml, water absorption index 1.73 mlH_2O/g, solubility index 40.60% and color (L) 80,47.

Suggestion
Based on the results of the study, it is recommended to dry cowpea sprouts using a temperature of 70ºC with a drying time of 16 hours.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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