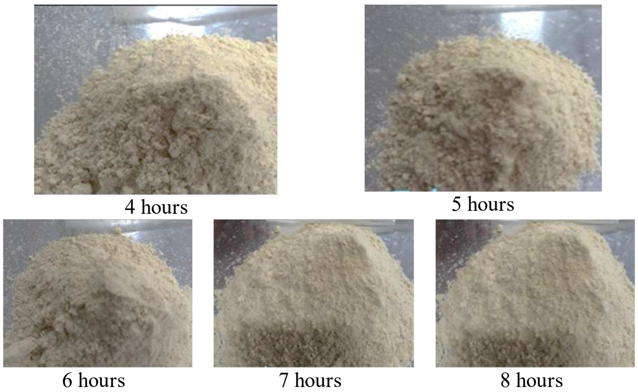

Fig. 2 Corncobs Powder with Different Drying Durations

B. Physical Properties

1) Water Absorption: Table 1 shows that the corncobs powder with different drying durations (4;5;6;7; and 8 hours) had a water absorption at 1.32-1.39 ml/g. The level of water absorption is influenced by the duration of drying time. In contrast to a previous study [22], flask powder dried by hot air at 70°C and frozen at 50°C showed a water absorption rate of about 2.60-2.74 g/g; and according to another study [22], the fruit powder that was dried with hot air at 70°C had a water absorption capacity of about 3.07g/g. The absorption rate of instant powder is affected by water content [23]. The increased water absorption may be due to the effects of reduced moisture and increased hygroscopicity of the product [24]. The study that conducted also said that the higher of the drying temperature then the faster the drying process [25].

TABLE I
PHYSICAL PROPERTIES OF CORNCOBS

Treatment	Component			
	Water Absorption (ml/g) (%)	**Solubility (%)**	**Whiteness (%)**	**Bulk Density (g/cm³)**
4 hours	1.39[a] ±0.01	27.91[a] ± 0.20	66.46[a] ±0.02	0.61[a] ±0.01
5 hours	1.38[b] ±0.01	27.52[b] ±0.19	66.51[b] ±0.02	0.62[b] ±0.01
6 hours	1.36[c] ±0.01	27.14[c] ±0.19	66.56[c] ±0.03	0.63[c] ±0.01
7 hours	1.34[d] ±0.01	26.76[d] ±0.19	66.62[d] ±0.03	0.64[d] ±0.01
8 hours	1.32[e] ±0.01	26.39[e] ±0.18	66.67[e] ±0.03	0.65[e] ±0.01

Data followed by different letters in the same line showed statistically significant ($p<0.05$).

2) Solubility: Corncob's powder has a solubility of 26.39-27.91%. In contrast, a previous study reported that the pumpkin powder had a solubility of 8.77-9.46% [26]. The solubility rate is influenced by the presence of water-soluble and water-insoluble components [27]. The higher the solubility, the better the corncob powder product [28]. In the process, activated hydrolytic enzymes break down various complex components into simple components. Amylase enzymes catalyze the breakdown process of starch and produce sugars by binding to peptide proteins and amino acid-producing proteins [29]. Many factors influence solubility, including process conditions, composition, particle size, density, pH, and storage conditions [30], [31]. Solubility means the ability of powders to dissolve in water. Based on the previous study the main factor that affecting the solubility is drying process [32].

3) Whiteness: The whiteness of corncobs powder ranged from 66.46-66.67%. The drying duration affects the degree of whiteness. The drying process allows dissolved compounds such as sugars and proteins to react and produce brownish pigments [33]. In addition, the low water content of the corncobs powder makes the powder dry completely and increases the whiteness of the produced corncobs powder. Meanwhile, at low drying temperatures and long drying duration, the corncob pieces are not dried completely, and some parts are brown in color because they still contain water and have a high Aw (water activity) value. The high-water absorption during the drying process will result in a larger shrinkage of volume and cause an increase in the intensity of the brown color [34]. The higher the intensity of brown color then the whiteness of powders will decrease [35].

4) Bulk Density: Bulk density is the ratio of the weight of a material to the volume it occupies, including the empty space between the granules of the material [36]. *The bulk density score will increase when the weight of material increase.* Density is used to determine the cohesiveness and texture of a material. The longer the drying time, the more water content is released [37]. The density value is influenced by the moisture content, particle size, and powder porosity [38]. Food that has a high bulk density shows a high nutrient density [39]. For example, corncobs powder with different drying times has an ash content ranging from 0.61-0.65 g/cm³. In previous studies, longer drying time increased the Bulk density of produced Belitung taro flour because more water was evaporated. So, solids with a large molecular weight, such as carbohydrates, will be more concentrated. Another study also explained that bulk density is a property that can be influenced by the size and moisture content [38]. The lower the moisture content of a material, the better the bulk density produced. This is because the low water content in dried materials will produce smaller and finer granules. In addition, materials that have a low moisture content make powder formation easier and prevent powder clumps [36].

TABLE II
NUTRITION CONTENTS OF CORNCOBS POWDER

Duration	Components					
	Water (%)	**Protein (%)**	**Ash (%)**	**Fat (%)**	**Carbo-hydrate (%)**	**Crude Fibre (%)**
4 hours	13.64[a] ±0.56	1.86[a] ±0.02	3.50[a] ±0.05	0.48[a] ±0.03	80.52 ±0.02	38.25[a] ±0.02
5 hours	12.55[b] ±0.56	1.90[b] ±0.02	3.56[b] ±0.05	0.53[b] ±0.03	81.46 ±0.02	37.40[b] ±0.02
6 hours	11.10[c] ±0.56	2.17[c] ±0.02	3.69[c] ±0.05	0.65[c] ±0.03	82.38 ±0.02	36.19[c] ±0.02
7 hours	10.26[d] ±0.56	2.20[d] ±0.02	3.73[d] ±0.05	0.77[d] ±0.03	83.04 ±0.02	35.77[d] ±0.02
8 hours	9.08[e] ±0.56	2.58[e] ±0.02	4.03[e] ±0.05	0.88[e] ±0.03	83.43[e] ±0.02	34.60[e] ±0.02

Data followed by different letters in the same line showed statistically significant ($p<0.05$).

C. Nutrition Content

1) Water Content: Table 2 shows that the corncobs powder with drying duration of 4;5;6;7; and 8 hours has a moisture content ranging from 9.08-13.64%. In contrast to the findings of previous studies [40], [41], the moisture content obtained ranged from 5.00-9.64%. The difference in drying duration most likely causes the various water content of corn cobs powder. The longer the drying duration, the more water content is lost due to evaporation. The statement is supported by the findings of a previous study [42], which stated that a long drying process and a higher temperature caused more water content to evaporate so that the material became drier and lighter, as the heating process can reduce the moisture content in the materials [43]. According to a previous study [28], moisture content higher than 14% in flour and powder will affect storage quality because it will create a flavourable condition for mold growth, insect infestation, and agglomeration.

2) Ash Content: Corn cobs powder with different drying durations has an ash content ranging from 3.50-4.03%. The level of ash content is influenced by the length of drying time. It is suspected that an increase in drying temperature will cause an increase in the ash content of the white oyster mushroom flour because of the water content in the white oyster mushroom flour. The chunks of mushrooms have a higher decline so that the remaining material in the mushroom increases, one of which is minerals [44]. The levels of ash contained in a material can be related to the number of mineral elements. The ash content depends on the type of material, method, drying time and temperature, and the non-mineral components contained in the material [45]. Oxidizers act as a proportion of minerals in the material [46].

3) Protein Content: Corncob's powder has a protein content of between 1.86-2.58% due to the different drying durations. Longer drying duration causes water evaporation on the material to be faster and leads to protein denaturation. The heating process can damage the amino acids in which the heat resistance of proteins is highly dependent on the amino acids that make up these proteins [45];[47]. A previous study suggests that the decrease in protein levels is due to the characteristics of the protein contained in food. Most dietary protein is denatured when heated at medium temperature (60-90^{0}C) for one hour or less [48]. The increase in protein content with a longer drying duration is due to the breakdown of water molecular components (H_2O) during the drying process. This causes a decrease in water content, thereby increasing other elements such as protein content. Oxidizers act as a proportion of minerals in the material [49].

4) Fat Content: Corncob's powder has a fat content of between 0.48-0.88%. The fat content will increase proportionally to the increase in temperature and drying duration. Longer drying duration increases the fat content, which decreases the moisture content [50]. According to a previous study [51], the fat breakdown rate varies depending on the processing time and temperature. Fats are easily damaged by oxidation and hydrolysis and are sensitive to light, temperature, and oxygen.

5) Carbohydrate Content: Corncob's powder has a carbohydrate content of 80.52-83.43%. The longer the drying duration, the higher the carbohydrate content. Some carbohydrates are damaged by the long drying duration resulting in lower carbohydrate content. Reduced water content means foods with high carbohydrates, protein, and minerals but less in vitamins [52].

6) Crude Fiber: Crude fiber is a heat-resistant part of food and cannot be hydrolyzed by the chemicals used in this study [49]. Corn cobs powder with different drying durations has a total crude fiber ranging from 34.60-38.25%. The decrease in crude fiber content in this study is probably due to the breakdown of hemicellulose resulting in a decrease in crude fiber content because hemicellulose is a part of crude fiber. Hemicellulose enzymes can break down hemicellulose and hemicellulose enzymes such as gluconate, xylanase, galactonase, manase, galactomannase, and pentosanase [51].

D. Phytochemical Contents

1) Total Phenol: Corncobs powder has a total phenol ranging from 112.83-113.58 mg/100 mg. The total phenol content depends on the drying duration. The longer the drying duration, the lower the total phenol. Drying and wilting can destroy some phenolic compounds leading to decreased polyphenol levels [53]. The number of tannins influences the decrease in antioxidant activity from dissolved flavonoid compounds because the epigallocatechin gallate in tannins is a flavonoid building block that acts as the largest antioxidant besides quercetin in flavanol compounds [54]. The phenolic compounds are very sensitive, unstable, and very susceptible to degradation [55]. Phenols in fruit and vegetables are susceptible to oxidative degradation by polyphenol oxidase during the drying process resulting in intermolecular condensation reactions and decreased phenol content. Oven drying uses a higher temperature than sun drying and wind drying. Inactivation of the polyphenol oxidase enzyme resulting in a higher total phenolic content [56];[57]. Previous studies found a strong correlation between phenol content and antioxidant activity. Phenolic compounds are easily oxidized and sensitive to heat so that the sun-drying process can even reduce the content of phenol compounds. Phenolic compounds such as flavonoids can inhibit free radicals through radical scavenging by donating one electron to an unpaired electron in the free radical. The total phenol content decreased with the increase in the drying duration of noni leaves due to the oxidation process during the heat treatment. The drying process reduces the phenol content in the leaves [58]. Phenolic compounds act as antioxidants because they can bind oxygen, which makes oxygen unavailable for the oxidation process, causing phenolic compounds to bind to metals, catalyzing oxidation reactions [59]. However, if exposed to oxygen for a long time, phenolic compounds will be oxidized, leading to a reduction in antioxidant activity and the total amount of phenol. The drying process of corncobs powders decrease the contents of bioactive compounds and antioxidant activity [60].

2) Antioxidants Activity: Corncobs powder has antioxidant activity ranging from 20.61-21.53%. The length of drying duration influences the level of antioxidant activity. According to previous studies [61];[62];[63], the longer the drying duration, the lower the antioxidant activity of corncobs powder. Meanwhile, according to another study [64], high drying temperature will also decrease the antioxidant activity because the high temperature causes damage to secondary metabolites that act as antioxidants. Also, previous studies [65] showed that the higher the drying temperature, the lower the antioxidant activity. The drying process decreases the active substances contained in the materials. The decrease in antioxidant activity is also influenced by the enzymatic oxidation process, which causes polyphenols to be oxidized and decreased [66]. According to a previous study, high temperatures in thermal processes can cause a significant reduction in antioxidants naturally found in plants which can also deactivate enzymes and decrease phytochemical compounds [67]. It means that the higher temperature in drying process will decrease the antioxidant activity [68]. The decreased activity antioxidant was also caused by different type solvent and extraction temperature [69].

TABLE III
PHYTOCHEMICAL CONTENTS OF CORNCOBS POWDER

Dry Duration	**Components**		
	Total Phenolic (mg/100mg)	**Activity Antioxidant (%)**	**Tannin (mg/L)**
4 hours	113.58[a] ±0.56	21.53[a] ±0.06	1.50[a] ±0.02
5 hours	113.42[b] ±0.56	21.40[b] ±0.06	1.49[b] ±0.02
6 hours	113.34[c] ±0.56	21.32 ±0.06	1.47[c] ±0.02
7 hours	113.30[d] ±0.56	21.28 ±0.06	1.46[d] ±0.02
8 hours	112.10[e] ±0.56	20.61[e] ±0.06	1.45[e] ±0.02

Data followed by different letter in the same line showed statistically significant ($p<0.05$).

3) Tannins: Tannin content in corncobs powder ranging from 1.45-1.50 mg/L. Based on the results of a previous study, the higher the drying time and temperature, the lower the tannin value of the tea produced. Tannins contain epigalocatekaloid, flavonoid constituent that acts as a potent antioxidant besides quercetin in flavanol compounds. These tannin components will undergo a lot of chemical changes at high temperatures.

Tannin oxidation is influenced by the presence of oxygen, solution pH, light, and antioxidants. The epigallocatechin component in tea will be oxidized into orthoquinones and then condense in the presence of hydrogen molecules forming biflavanols. Then, the bioflavanol components will condense to form theaflavins and thearubigines which contain lower polyphenols [70]. Based on the result of another study, it known that tannin content will decrease after heating process in drying [71].

IV. CONCLUSION

Corncobs powder with a drying duration of 7 hours has the best physical properties (water absorption at 1.34 ml/g, solubility at 26.76%, whiteness at 66.62%, and bulk density at 0.64 g/cm^3), nutritional contents (water content at 10.26%, ash content at 3.73%, protein content at 2.20%, fat content at 0.77%, carbohydrate content at 83.04%, and crude fiber at 35.77%), and phytochemical content (total phenol at 113.30 mg/100mg, antioxidant activity at 21.28%, and tannins at 1.46 mg/L).

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