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Physical Characteristics and Shelf Life Estimation of Instant Powder Drink Made From The Combination of Yellow Sweet Potatoes and Red Beans

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ABSTRACT

Introdiction: In this modern era, people demand everything fast and practical. Likewise, in terms of food or beverage, people tend to prefer instant products. Instant products are food or beverage products that are easy to serve or consume in a relatively short time, such as instant powdered drinks. The physical characteristics of instant products can be interpreted as the essential properties of their ingredients in addition to chemical and biochemical properties. The physical characteristics are needed to develop instant products that are useful for producing quality food or beverage products. **Aims**: Instant powder drink product from the combination of yellow sweet potatoes and red beans need to be analyzed for their physical characteristics through yield, water absorption, solubility, viscosity, and shelf life. **Result:** The results of the analysis showed that the instant powder drink product combination of yellow sweet potato and red bean had a yield of 30.40%, a water absorption capacity of 4.98 ml, a solubility of 63.42%, and a viscosity of 14.80 cp. At the same time, the shelf life of this product is based on the assumption of average storage temperature in Indonesia (around 28ºC-38ºC), which is approximately 5 months of shelf life. **Conclusion:** Based on the results of the analysis, instant powder drink products have fairly good product stability and the product can be stored at room temperature or refrigerator.

KEYWORDS: Instant powder drink, yield, water absorption, viscosity, shelf life

INTRODUCTION

The development of people's lifestyles which are currently complex, demands the availability of various ready-to-eat or instant products. Instant food or drink products are food or drinks products that are easy to consume and served quickly (Lawal, 2017). According to Arjunan (2012) instant food products are suitable products, this is because instant products can be consumed immediately with or without prolonged cooking (Juliano, et al., 2015).

By definition, instant powder drinks are drinks in the form of fine powder or granules which made from spices or fruits or seeds or leaves. Instant powdered drinks can be served quickly by brewing with cold or hot boiled water. Thus instant powdered drinks are practical drinks because they are easy to serve, that is, by simply adding hot or cold water and stirring briefly, you get ready-to-drink drinks and are ready to be enjoyed in a relatively short

time (Ratnaningrum 2015; Affandi, 2017).

Powder drinks that have undergone processing in powder form (instant) are a good alternative for providing practical and healthy drinks (Kopelmann, 2007). The advantage of the instant drink powder form is that it is not hygroscopic (absorbs water), so it does not agglomerate, and when wetted, the instant powder will be dispersed, dissolved, and more stable. In addition, other advantages possessed by products in the form of instant powders are longer shelf life, easier to package, easier to serve, and ease of distribution (transportation) (Utami, 2016; Affandi, 2017).

Instant powder drink products using local food are currently being promoted. In addition to increasing the purchasing power and consumption of local food, it is also hoped that it can improve the nutritional status of the community through the consumption of local food. Sweet potatoes and red beans are local foods that are easy to find and have the potential to be developed as local agro-industry. Sweet potatoes and red beans are one of the favorite foods of the Indonesian people. The reason is, besides being easy to process, sweet potatoes and red beans are also local foods that have good nutritional value (Maria, 2015). The manufacture of instant powder drinks uses the principle that yellow sweet potatoes and red beans are made in the form of a soft puree so that they can be mixed with other ingredients to produce powder. The combination of these two ingredients is expected to produce an instant powder drink that has high nutritional value as well as has good physical stability.

The formulation of instant powder drink needs to pay attention to its physical characteristics. This is important because: 1) the physical characteristics of a food or beverage product are an early indicator for assessing the quality of a product, 2) it can be used as a basis for determining the effectiveness of product processing, 3) knowing how quickly the food or beverage product is damaged or no longer exists. Suitable for consumption, 4) and can be used as a basis for further product technology development (Ratnaningrum, 2015). Therefore, this study aims to analyze the physical characteristics and shelf life of instant powder drink products made from a combination of yellow sweet potato and red beans. This research is the first study to look at information on the physical properties and shelf life of beverage products from a combination of yellow sweet potato and red bean.

This research is expected to provide information about the physical properties and shelf life to guarantee that the product is still fit for consumption and has not been damaged.

MATERIAL AND METHODS

Location and Materials

The manufacture of instant powdered drinks, analysis of physical properties and shelf life were carried out in the nutrition laboratory at IPB University. While the drink

drying process was carried out at Food Processing Pilot Plant Seafast IPB University.

The yellow sweet potatoes and red beans used were obtained from Surya Kencana Market of Bogor City. The selected sweet potatoes are sweet potatoes with a harvest age of 4-4.5 months, while the selected red beans are fresh red beans or dry red beans which have a smooth surface, are not wrinkled and have holes, do not sprout, and the color is not red-black. For other ingredients such as soy protein isolate obtained from LPY Nutrition in Kab. Kudus, Central Java; red palm oil (RPO) obtained from PT. Nutri Palma Nabati in Kab. Bogor; and other supporting ingredients such as egg white flour, honey and sugar powder obtained at the Local Market in Bogor City.

The equipment used in this study were: 1) making instant drinks including stoves, knives, cutting boards, pans, blenders, food, beakers, and stopwatches.

Production of Instant Powder Drinks.

The production scales, bowls, filter cloths and double drum type Armfield FT32 for Laboratory; 2) analysis of physical properties including ovens, Memmert water baths, desiccators, analytical scales, centrifuges, test tubesof the drink refers to the procedure for sweet potato leaf drink production by Windardi (2016) with a modification of replacing the main ingredient, which are yellow sweet potato leaves into yellow sweet potato tuber meat plus red beans as the main ingredient. The manufacture of yellow sweet Physical characteristics and shelf life estimation potato and red bean drinks is carried out through several stages: preparation of the main ingredients, mixing and drying. The main ingredient preparation process in the form of yellow sweet potato and red bean is intended to obtain puree from these two ingredients. The puree of the two ingredients is then weighed according to a predetermined weight. After weighing, red bean puree and yellow sweet potato are mixed with other ingredients that have been weighed previously in the form of red palm oil, soy protein isolate, maltodextrin, egg white flour, vanilla essence, powdered sugar, and honey. The process of mixing the ingredients is done using a blender for ± 5 minutes. After the mixing stage, the resulting drink is filtered to separate the dregs from the mixing results using a blender. The next stage is drying the drink using a drum dryer. The drying results using a drum dryer were then 3 to 5 times sifted to produce a finely powdered drink. Instant powder drink formulations can be seen in Table 1.

Analysis of Physical Characteristics.

Analysis of the physical characteristics of instant drink product consisted of yield (AOAC, 2005), solubility (Yuwono & Santoso, 1998), viscosity (AOAC, 1995), and water absorption (AOAC, 2005). Yield is carried out to determine the percentage of the product produced after drying to the amount of raw material or formula before drying. The solubility test was carried out to determine the percentage of dissolved powder based on the

Table 1. Formulation of instant powder drinks per serving

Ingredients	Grams
Yellow Sweet Potato	30
Red Beans	10
Red Palm Oil (RPO)	10
Soy Protein Isolate	15
Egg White Flour	8
Honey	10
Sugar Powder	10
Maltodextrin	13

amount of insoluble sample after being dissolved with water. Viscosity was measured to determine the beverage sample's viscosity level using a Brookfield Viscometer Spindle 2. Water absorption was carried out to determine the ability of the sample to absorb water (Astawan and Hazmi, 2016).

Estimation of Shelf Life.

Determining the shelf life of products is carried out using the Accelerated Shelf-Life Testing (ASLT) method, which is an approach to determining the shelf life of food products by storing products in an environment that can accelerate the decline in product quality. The ASLT estimation model used the Arrhenius approach with the TBA value parameter. The model for estimating shelf life with this method is appropriate when used on sensitive or easily damaged products due to rancidity in food products (Labuza, 1982). The TBA value indicates the degree of rancidity of food products due to oxidation or hydrolysis of food components through the malonaldehyde (MDA) content in food products (Ovani, 2013). The product to be analyzed is stored for four weeks and the TBA number is analyzed weekly. The product shelf life using the Arrhenius approach is carried out by storing packaged products at three different temperatures, namely 25, 35, and 45 ºC. The determination of the three temperature levels is based on the actual temperature range in Indonesia and the conditions that usually occur during the distribution and storage of products during sales (Iswahyudi, 2015).

RESULTS AND DISCUSSION

The physical characteristics of instant powder drink products observed were the basic physical characteristics of powder-form drinks: yield, solubility, water absorption, and viscosity (Chandan, et al., 2016). The results of the physical analysis of instant powder drink products are presented in Table 2.

Yield of Instant Powder Drink

The yield of instant powdered drinks is obtained based on calculations on a dry basis. Yield is indicated by the percentage of the amount of product produced after drying to the amount of raw material or formula before drying. Table 2 shows the yield of instant

Table 2. The results of physical characteristics analysis of instant powder drink

Parameter	Results
Yield (%)	30.40
Water Absorption (ml/g)	4.98
Solubility (%)	63.42
Viscosity (cp)	14.80

powder drinks, namely 30.40%. The high yield rate is likely due to the addition of Maltodextrin.

Maltodextrin is one of the ingredients that affect the yield of powdered drinks. Based on Endang and Prasetyastuti (2010), maltodextrin can function as a mass enhancer and increase the total solids of a product. The greater the amount of maltodextrin added, the higher the product yield. Therefore the addition of 13 grams of maltodextrin can increase the total solids in the dried material with a higher yield.

Apart from maltodextrin, the addition of sugar to the drink is also thought to cause a higher yield. This is due to the nature of sugar which can be used as a filler which can be used to recrystallize food and provide stability. The use of sugar in the manufacture of food products will cause an increase in total solids so that the yield obtained is greater (Kim, et al., 2011).

Water Absorption

The analysis results on the water absorption parameters of instant powder drinks are 4.98 ml/g. These results indicate that every 1 gram of drinking powder can absorb about 5 ml of water (rounded off from 4.98 ml). Based on these results, it can be determined that the ratio between drinking powder and water to make yellow sweet potato and red bean drinks is 1:5. This means that to make 1 serving of instant drink powder (50 g), 250 ml of water is needed.

Water absorption generally describes the ability of a material to absorb water. According to Mirdhawati, (2004), the water absorption capacity of a material is influenced by its constituent components, such as proteins and carbohydrates. In this case, carbohydrate molecules are starch found in beverage products, which can affect water absorption. Starch that binds to water will gelatinize, so cavities will form in the product structure (Kusnandar, 2010). The more gelatinized starch, the more air cavities will be formed. The more air cavities that are formed when rehydration occurs, the more water will be trapped in the drink powder, so the level of water absorption will also increase (Permana & Putri, 2015).

Rehydration power also depends on the availability of hydrophilic groups, in this case, related to proteins. According to Astawan and Hazmi (2016), water absorption can be affected by the protein's ability to bind water due to the presence of hydrophilic groups. Water absorption will increase with increasing protein concentration in the material (Richana, 2004).

Solubility

The solubility value of a product is one of the important parameters and is one of the requirements for instant powder drinks. The higher the solubility value, the product will be better because the amount of dregs produced is less. The measurement results for instant powder drink products are 63.42%. The solubility value indicates that the solubility of

the product is still low from the requirements of SNI 01-4320-1996 concerning the solubility of powdered drinks, namely at least 75%. According to Susanti & Putri (2014), the low solubility of the product can be affected due to the high content of water-insoluble components such as water-insoluble dietary fiber and resistant starch. In addition, solubility is also influenced by protein content, especially amino acids which contain more hydrophobic groups in the product. Although protein can increase the solubility of a product, according to Winarno (2008), denatured protein due to the high heating process will reduce its solubility because the hydrophobic inner layer of protein molecules turns outward, while the hydrophilic outer layer folds inward. Proteins with more hydrophobic groups will reduce the solubility of the product in water.

Viscosity

Every liquid has a thickness or viscosity. The viscosity test is one of the important parameters in measuring the level of viscosity of a liquid or fluid product. Viscosity or thickness is one of the properties of a liquid or fluid that determines the amount of resistance to frictional forces. The greater the viscosity of the liquid, the more difficult it is for an object to move in the liquid. The National Dysphagia Diet Task Force classifies the viscosity of a liquid according to its viscosity, namely: 1) liquid (1-50 cp), which includes all drinks, 2) similar to nectar (51-350 cp), 3) like honey (351-1750 cp) , and 4) very viscous (over 1750 cp) (Creech, et al., 2019). The result of measuring the viscosity of the instant powder drink is 14.80 cp. These results indicate that the viscosity of beverage products in this study has met the viscosity value for beverage products because it is included in the "liquid" group. The viscosity value of this research product is much higher than similar products. Dairy products made from vegetable ingredients and powdered drinks made from herbal ingredients have viscosity values of 4.2 cp and 1.2 cp, respectively (Sentana, et al., 2017; Pudiastutiningtyas, 2015). According to Sentana, et al. (2017), the presence of total solids such as higher carbohydrate, protein and fiber components tends to increase the viscosity of a product. The high content of protein and carbohydrates in this product is thought to affect its viscosity.

Estimation of Shelf Life

Determination of Critical Point Parameters.

One of the factors that can affect the shelf life and decrease the quality of food products is the change in the TBA number of the product during storage. Damage to food products through changes in TBA numbers is caused by rancidity due to oxidation or hydrolysis of food components. The level of

Table 3. The value of r^2 at ordo zero and ordo one

Parameter	Tempp (ºC)	r^2	
		Ordo Zero	Ordo One
TBA Value	25	0.0548	0.0398
	35	0.6901	0.7317
	45	0.7504	0.7593

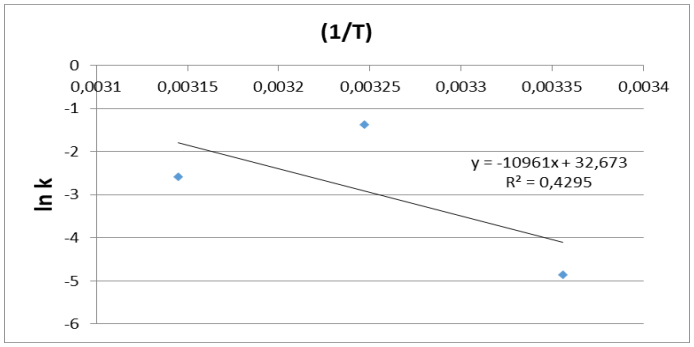

Figure 1. Graph of the relationship between ln k TBA and temperature (1/T) in instant powder drink product

damage was measured through Tio Barbituric Acid (TBA) analysis (Herawati, 2008). TBA analysis is a specific test for the oxidation of unsaturated fatty acids. Generally applied to products with food fats containing fatty acids with a higher degree of unsaturation which can affect the stability of the rancid flavor of the product (Kusnandar, 2010).

The results of measuring the fat content of instant powder drink products contain quite high fat, namely 9.92% per 100 g, so the potential for damage due to fat oxidation may occur. According to Sabarisman, et al. (2017), a decrease in the quality of fatty products in powder form will cause the product to become rancid if stored for a long time. This is caused by the increasing amount of oxidized fat so that the product will experience a decrease in quality, leading to product damage. Because crucial fatty acids and vitamins (such as beta-carotene and tocopherols) are damaged due to fat oxidation, it can also diminish the nutritional value of food (Maharani, et al., 2012; Patty, 2015).

Determination of Reaction Ordo.

The first stage in determining the shelf life is to make a regression curve of the relationship between the observed parameters and the length of storage. The x value on the curve is the product storage time, while the y axis is the parameter value (TBA number) observed. The next step is to determine the ordo of the reaction. The ordo of the reaction, namely ordo zero and ordo one, shows the rate or speed of change in the quality of the observed parameters. If the damage rate is constant or linear, then it follows zero reaction ordo. Meanwhile, if the damage rate is not constant or exponential, then it follows the first reaction ordo. The choice of reaction ordo is determined by the larger correlation coefficient (r^2). The r^2 values for the zero reaction ordo and the first reaction ordo are presented in Table 3.

Based on Table 3, the first reaction ordo is determined as the selected reaction ordo. According to Labuza (1982), types of spoilage of foodstuffs that follow ordo one kinetics include rancidity, microbial growth, production of off-flavors (distorted flavors) by

Table 4. Selected ordo equation (Ordo One)

Temperature in Celcius	Temperature in Kelvin	(1/T)	Selected Ordo Equation	*Slope* (k)	ln k
25	273+25= 298	0.003356	y = 0,0078x - 0,2477	0.0078	-4.853631
35	273+35= 308	0.003247	y = 0,2527x - 1,8366	0.2527	-1.375552
45	273+45= 318	0.003145	y = -0,075x - 1,2612	0.0750	-2.590267

microbes in meat, fish, and poultry, vitamin damage, decreased protein quality, and so on. This shows that the type of damage to this beverage product is rancidity because the selected reaction ordo follows reaction ordo one

Shelf Life Calculation.

The reduction in TBA value of the product is processed based on the ordo zero and ordo one reactions. Based on Table 3, the value of r^2 which is greater or close to one is more common in ordo one, so henceforth the calculation of the shelf life of the product follows the ordo one reaction. By calculating the slope of the regression equation between the ln TBA value and the time of testing at three temperature variations, the equations of the selected ordo lines, k values, and ln k are obtained as presented in Table 4.

The beta graph with a linear equation can be used to compute the value of k, which can be used to determine the product's shelf life, by graphing the inverse of the absolute temperature (1/T) against ln k.

Based on Figure 1, the Arrhenius equation is obtained: y = -10961 (1/T) + 32.673, with R^2 = 0.4295 which indicates that the rate of change or the type of damage to the product is following ordo one because the number has passed of zero. The types of damage that follow first-order reaction kinetics are rancidity, microbial growth, off-flavor production, vitamin damage, and protein quality degradation (Labuza, 1982). This is appropriate because the parameters measured in this study are TBA value. From this equation, the value of k can be obtained, which can be used to calculate the product's shelf life. The value of k (quality change rate constant) is obtained from ln k = ln ko –(Ea/R)(1/T), where ln ko is the intercept value of the Arrhenius equation and Ea/R is the slope value of the Arrhenius equation. The k value obtained is then entered into the reaction kinetics equation based on the ordo of the reaction. The TBA number parameter follows ordo one reaction. The results of calculating the shelf life of instant powder drinks at various storage temperatures can be seen in Table 5.

Table 5 above shows that the higher the storage temperature, the shorter the drink's shelf life. The most extended shelf life of instant powder drink products is 194 days (6 months) at 25ºC, while the shortest is 46 days (1.5 months) at 45ºC. Based on the 3 types of temperatures applied to instant powder drink products, namely 25ºC, 35ºC and 45ºC, it is concluded that instant powdered drinks have a shelf life of 5 months, assuming the average storage temperature in Indonesia is 28ºC-38ºC

Table 5. The shelf life estimation at various temperatures

Parameter	Temperature (ºC)	k Value	Shelf Life	
			Days	Months
TBA Value	25	0.0164	194	6
	35	0.0541	138	4.5
	45	0.1618	46	1.5

(temperature starting from storage in the warehouse until the consumer receives the product). Compared with other studies using the same method and the same product form but the ingredients used are different, the average age of instant powder drink products is in the range of 1-20 months. The difference in the shelf life of each product is due depending on the ingredients used and the parameters used, such as water content and number TBA (Darniadi, 2020; Mustafidah, 2015; Della, 2010).

CONCLUSION

The results of the characteristic analysis of instant powder drink products based on four parameters showed a yield of 30.40%, water absorption of 4.98 ml, solubility of 63.42%, and viscosity of 14.80 cp. While the shelf life of this product is approximately 5 months based on the assumption of the average temperature in Indonesia. Produk minuman ini diharapakan dapat menjadi produk minuman alternative yang dapat dikonsumsi oleh semua usia dengan stabilitas produk yang cukup baik. Recommendations for further research: it is necessary to analyze primary and secondary metabolites of the product, analyze antioxidant activity, and measure storability using other parameters that are thought to influence the decline in the quality of beverage products.

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