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OPTIMIZATION OF ELEPHANT FOOT YAM (*Amorphophallus Paeoniifolius*) EXTRACT SYRUP FORMULA AS A NUTRITIVE ANTIOXIDANT DRINK

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ABSTRACT

Extract of Elephant Foot Yam (EFY) is known to contain flavonoid that is an antioxidant compound and thus has the potential to be utilized as functional food in the form of beverages. Functional drinks made from plants are usually presented as healthy drinks, which in this case is in the form of syrup. This study aims to determine the antioxidant activity, pH value, viscosity and sensory properties of EFY extract syrup with different extract formulas and find out which of the formulated syrup produced is best based on its antioxidant activity and physical characteristics. The syrups produced were derived from 3 different types of formulas determined which were F1 (0.6% extract), F2 (2% extract) and F3 (4% extract). The parameters observed in this study were antioxidant activity, pH value, viscosity, and sensory properties of the syrup. The results obtained show that variations of the extract concentration in the formula have effects on the antioxidant activity, pH value, viscosity, aroma, and consumers' preference of the syrup. The syrup formula with a concentration of 4% extract (F3) was found to have favorable properties as it has the highest antioxidant activity of 71.39 ppm; pH value of 4.97; and viscosity 0.265 c. In terms of consumer's preference, the syrup with 0.6% extract (F1) is most preferably in color, flavor, and aroma. Thus EFY potentially as antioxidant source that can be added into the healthy drink in the form of syrup.

Contribution/Originality: This study is one of very few studies that have investigated the potency of a tropical tuber grown primarily in Southeast Asia namely Elephant Foot Yam (EFY) as a functional baverage in the form of syrup preparation.

1. INTRODUCTION

As one of the megadiverse countries in the world with biodiversity second to Brazil, Indonesia is home to a really big portion of world's flora scattered in its tropical rain forest. One type of flora that can be found is elephant foot yam (EFY). EFY with the scientific name as Amorphophallus paeoniifolius is a tuber plant originating from the *Araceae* plant family. This paticular tuber plant is considered to be one of the most important types of tubers because it has culinary properties and potential economic value that can be developed (Singh and Wadhwa, 2014). Yam tubers are usually consumed as rice substitutes by Indonesian people in certain areas and as raw materials in the food industry to be exported. Based on datas from the Central Bureau of Statitistics of Indonesia's overseas export bulettin, suweg and other forms of yams were some of Indonesian agricultural commodities exported in the form of chips or flour to various countries such as Japan, Italy, Australia and several other countries (Afifah *et al.*, 2014).

EFY have long been used in the Ayurveda treatments, a traditional Indian medicine system that uses plants and herbs to treat various diseases (Mahesh *et al.*, 2014). Studies have shown that EFY contain an antioxidant compound called flavanoid. The statement is supported by a study (Nataraj *et al.*, 2012) which states that based on the results of phytochemical screening of EFY extract, there was presence of phytophosinidants such as tannins, flavonoids, sterols, polyphenols, and coumarins known as powerful natural.

Interests in utilizing antioxidants from plant sources have increased as we become more aware of their potential and effectiveness. Natural antioxidants found in plants have been studied and used to protect the human health and oxidative damages in food products by inhibiting lipid peroxidation, eliminating free radicals and reactive oxygen species, and chelating heavy metal ions (Akula and Odhav, 2008). Utilization of natural antioxidants to prevent diseases and protect food products has shown to have reduced the use of synthetic antioxidants that have potential health risks and toxicities still in question (Kosar *et al.*, 2008). Many researchers have used plant extracts that contain antioxidants in food products aimed at improving nutritional value, flavor, and making antioxidant rich food.

Utilization of EFY in Indonesia can be considered as still limited to certain areas and not optimized, so it is less well known in the wider community even though suweg has active components that can be made into functional food. Functional food is a food that has physiological effects on the body, improves the general condition of the body, reduces the risks of diseases, and is even used to cure some diseases (Siro *et al.*, 2008). Nowadays, a lot of people are using plant extracts that have been processed into functional food in the form of beverages. Functional drinks made from plants are normally presented in the form of healthy drinks and one can be made into syrup (Miksusanti *et al.*, 2011). Healthy drink trends are currently in demand because it is believed to be efficacious for the health. The phenomenon shows that more and more consumers are aware of the importance of health and as result functional food products have now become a trend in the society.

Syrup is a beverage made primarily by dissolving sugar and can have a variety of flavors (Bowman, 2017). Syrup can be thick or dilute, it is practical, favored by many people, and has great marketing potential (Hartiati *et al.*, 2009). In general, syrup is taken orally. Henceforth, its taste becomes really important to the consumers. Subsequently, it should be noted that the formula the syrup being produced would have desirable properties. Exploration of the use of different formulas of EFY extracts is expected to provide useful information regarding the antioxidant content and physical characteristics of the resulting syrup. This study aims to determine the antioxidant activity, pH value, viscosity and sensory properties of syrup containing EFY extract with different concentrations of the extract and find out which of the formulated syrup produced is best based on its antioxidant activity and physical characteristics. This research is hoped to be able to provide information to the readers concerning the potential of EFY as antioxidant properties served in the form of syrup. This research is also a manifestation of effort to utilize local commodities and improve the reputation of local food.

2. MATERIALS AND METHOD

2.1. Samples Collection and Extract Preparation

Samples of EFY were collected from the Temanggung, one of district in Java Island, Indonesia. The process of making EFY extract consists of several stages: drying, simplisia (dried herbs) making, maceration process, and evaporation of extract (Datta *et al.*, 2013). In the first stage, the EFY as raw material that were going to be turn into an extract were peeled, washed, and thinly sliced to simplify the process of drying it into simplisia. The drying process is carried out at 40°C for 24 hours with dry oven method. The drying was considered over when dry simplisia that could be easily broken and had a water content of less than 8% was obtained. EFY simplisia was then blended and sifted into fine powder. The powder was later dissolved with 70% technical ethanol using the maceration method for 48 hours. Every 20 g of dried simplicia powder was dissolved with 250 mL of 70% technical ethanol. After the maceration process, the solution was filtered using filtering paper to remove any powdered remnants from the simplisia solution. The remnant was then reconstituted using 70% technical ethanol. The obtained solution was then evaporated using a rotatory evaporator at 40°C to remove the solvent and obtain a viscous extract.

2.2. Preparation of EFY Syrup

Based on the estimated dietary intake of polyphenols, flavonoids of 1 g / day represent about two thirds of the total polyphenol food intake. One of its main sources are fruits and to a lesser extent vegetables (Scalbert and Williamson, 2000; Landete, 2013) hence the prepared EFY extract ingredient of the syrup was added to the mixture with varying concentration levels of 1 g, 3 g, and 6 g. Of the three concentration levels of the extract we would find out at which level of concentration does, the syrup has the best antioxidant and syrup characteristics. The process of making EFY extract syrup was carried out based on a formulation through several steps (Lisprayatna *et al.*, 2012) and the ingredients as seen in Table 1 were then mixed and cooked at 65 ° C.

Table-1. EFY Extract Syrup Formula

Ingredients	F_1	F_2	F_3
EFY Extract (% b/v)	0.6	2	4
Sucrose (g)	93	93	93
Propylene Glycol (g)	16.5	16.5	16.5
Citric Acid (g)	0.45	0.45	0.45
Strawberry Essence (mL)	2.5	2.5	2.5
Aquades (mL)	150	150	150

Source: Lisprayatna *et al.* (2012)

2.3. Antioxidant activity

Analysis of antioxidant activity was done using DPPH method (Rohman and Riyanto, 2005). A total of 100 µL test sample solution was added with 1.0 mL DPPH 0.4 mM and ethanol up to 5.0 mL. The mixture was subsequently vortexed and left for 30 minutes. The solution mixture was then measured for absorbance using a UV-VIS spectrophotometer at 517 nm wavelength. Furthermore, blank measurement was also taken. The magnitude of antioxidant capability was calculated by comparing the delta of the sample's absorbance measurement with the blank measurement then multiplied by 100%.

2.4. pH Value

The pH value measurements were performed using a digital pH meter device that worked on the principle of glass electrode (Kumar and Goel, 2015). Before used, the digital pH meter was first calibrated using a buffer tablet. The pH meter was then immersed into the sample and the pH values that appeared on the pH meter were recorded until a stable value was found.

2.5. Viscosity

Viscosity measurements were performed using the Ostwald viscometer (Beaulieu *et al.*, 2017). The syrup tested was inserted into the viscometer and was allowed to flow down through the capillary in the viscometer. On the capillary there were two boundary marks: the upper and lower border marks. As the syrup flowed and reached the upper limit boundary the stopwatch would turn *"on"*, and when the flow reached lower limit mark the stopwatch would be *"off"*. The time required for the syrup to flow between the two marks was then recorded. The viscosity measurement value using the Ostwald viscometer was calculated using the formula proposed by Liu *et al.* (2017).

2.6. Sensory Properties Test

Sensory properties tests were performed by 25 semi-trained panelists to measure the comsumability of the three differently formulated EFY extract syrups. This test was done by giving scale values for *taste*: 1 = not sweet, 2 = barely sweet, 3 = sweet enough, 4 = sweet; *color* 1 = not red, 2 = barely red, 3 = red enough, 4 = red; and *aroma*: 1 = not unique to EFY, 2 = bare aroma unique to EFY, 3 = noticeable EFYaroma, 4 = aroma unique to EFY. The panelists were also given scale values to determine the overall desirability of the three syrups that were 1 = dislike, 2 = barely like, 3 = quite like, 4 = like. The panelists gave assessments of the products that have been randomly coded on the questionnaire sheet provided.

2.7. Data Analysiss

The results of measurements of antioxidant activity, pH value, and viscosity tests were analyzed descriptively, while the data attained from the sensory properties test was analyzed using the *Kruskall Wallis* test. If there were real differences in results between each syrup and treatment, the data would then be further analyzed using the *Mann Whitney U* test.

3. RESULTS AND DISCUSSIONS

3.1. Physicochemical Properties of EFY Extract Syrup

Table-2. Result of Physicochemical Properties Tests of EFY Syrup Formula

Kind of Formulas	Antioxidant Activity (ppm)	pH Value	Viscosity (cP)
F_1	91.86 ± 1.088	3.80 ± 0.026	0.261 ± 0.019
F_2	83.05 ± 0.487	4.56 ± 0.017	0.263 ± 0.028
F_3	71.39 ± 1.753	4.97 ± 0.015	0.265 ± 0.010

Data was expressed as mean ± SD. F_{1-3} is syrup formula with 0.6%; 2%; and 4% extracts respectively.

3.2. Chemical Properties of EFY Extract Syrup Formula

Analysis on Table 2 shows that the F_1 syrup has antioxidant activity with IC_{50} value of 91.86 ppm, F_2 equals to 83.05 ppm, and F_3 71.39 ppm. All treatments indicate strong antioxidant activity. Blois (1958) stated that antioxidant activity with IC_{50} value of 50 ppm - 100 ppm is quite strong. F_3 treatment syrup has the highest antioxidant activity in comparison to F_1 and F_2 treatments. Indah *et al.* (2016) stated that the smaller the value of IC_{50}, the greater the antioxidant ability. This study shows that effect caused by different concentrations of extract on the antioxidant activity of the syrup exists. With the increase of concentration of extract used, the antioxidant activity of the syrup also increases. This is because the EFY extract used in this manufacture of syrup contains flavonoids. Flavanoid is a substance that has powerful natural antioxidant. Nataraj *et al.* (2009) stated that the flavonoids contained in the EFY extract amounted to 46.33 mg/g. This explains that the compound play a role in enhancing the antioxidant activity of the syrup. Shakeel *et al.* (2015) reinforces this statement in the claim he made that said in the manufacture of Entoban syrup, the addition of dosage of the extract can increase antioxidant ability of the syrup due to the presence of flavonoid compound in the extract that act as a reducing agent.

The pH value of F_1 syrup is 3.80; F_2 4.56 and F_3 4.97. The results show that the syrups produced were acidic. Suja *et al.* (2012) stated that the EFY has a pH value range of 4 - 5. These results also show that as the concentration of extract used was increased, the pH value of the resulting syrup also increased. It is suspected that the pH of the EFY extract has markedly affected the pH of the syrup. According to Anggraini *et al.* (2016) the duration of the extraction process can cause an increase in pH value of an extract, caused by the increase of the components extracted. If the extract is dissolved in water, the ratio of hydrogen ions to the hydroxyl ions will change. If the number of hydroxyl ions is greater than the number of hydrogen ions, the solution is basic and the pH rises, and vice versa. The addition of aquades and sucrose to the syrup may also affect the pH of the syrup.

Addition of water or sugar will cause ions (H^+) derived from organic acids to dilute, so that the ions (H^+) that form the acid will get reduced and the pH will increase. This is in accordance with the opinion of Winarno (1997) in Agustin and Princess (2014) that an acid which is added into water will result in the increase of hydrogen ions (H^+) and the reduction of hydroxide ions (OH^-) and with that the pH of the substance will decrease and vice versa. Apandi (1994) added that sugar can be used to increase the pH value of food products. The pH value is a really important parameter to find out as it indicates the chemical stability of the syrup. In addition, knowing the pH value of a product can also help identify and prevent the possibility of health problems arising from a product. The pH standard (SNI) for syrup in Indonesia is still not established. Banker and Rodhes (2002) suggest that the recommended pH value for syrup is approximately 3 to 6. If the syrup has a pH less than 2 then it can cause irritation in the stomach because it is too acidic. Mogadham *et al.* (2015) in the study of Prunus domestica syrup stated that the syrup has a pH value of 3.48 while Jain *et al.* (2017) states in his research Shankhpushpi syrup has a pH value of 4.04 to 4.20. The results showed that the pH of EFY syrup had met the pH criteria of syrups which ranged from 3 to 4.

3.3. Physical Properties of EFY Formula

3.3.1. Viscosity

The data obtained from the viscosity tests of EFY extract syrups were that F_1 had a viscosity value of 0.261 cP, F_2 viscosity value was 0.263 cP, and F_3 with viscosity of 0.265 cP. The higher the concentration of extract used the more viscous the syrup turned out. The amount of extract dissolved in the syrup would add to the total dissolved solids so that the viscosity would also increase. This is in accordance with the opinion of Pratama *et al.* (2012) that the addition of raw materials used will increase the total dissolved solids. The total dissolved solids will have been more than it is previously so that the viscosity level on the syrup will increase. Bourne (1982) reinforces this statement by stating that one of the factors affecting the viscosity is the solute.

In general, substances that can increase its value which are sucrose and propylene glycol influence viscosity. Winarno (2002) stated that increased viscosity can be caused by the addition of sugar. Sucrose has the ability to bind free water during the heating process to make the solution become more viscous. Lisprayatna *et al.* (2012) suggested that the higher the level of propylene glycol added to the syrup formula, its weight and viscosity will increase. Other factors such as temperature and heating duration can also affect the viscosity of the syrup.

The temperature and duration of the boiling process of the syrup will cause the water to evaporate and the solution to thicken or become more concentrated. Thus, the viscosity will increase. This is in accordance with the opinion of Puspasari *et al.* (2009) that during the boiling process, evaporation occurs that can concentrate the solution and increase the viscosity. Viscosity is a physical property highly distinctive to syrup. However, Indonesia has not set a standard (SNI) for viscosity in syrup. Based on previous researches, viscosity correlates strongly with the time it takes for a certain volume of syrup to flow. If the viscosity is low then the liquid will flow easily and vice versa. Husen *et al.* (2015) in his research, Sidaguri leaf extract syrup, stated that the viscosity of a syrup could be considered as adequate if the liquid could be easily poured out of its container when it's going to be consumed. EFY extract syrups created in this research each have viscosities that are not too high (relatively low) and can be easily poured. Thus, it can be said that the syrups produced have met the viscosity criteria expected of syrup.

3.4. Sensory Properties Test

Table-3. Sensory Properties Test of EFY Extract Syrup

Sensory Parameters	Syrup Formulas			Criteria scale (1-4)
	F_1	F_2	F_3	
Taste	3.48 ± 0.653^a	3.28 ± 0.613^a	2.88 ± 1.013^b	Not sweet – sweet
Color	3.52 ± 0.585	3.44 ± 0.650	3.20 ± 0.866	Not red – red
Aroma	2.72 ± 0.791^a	2.76 ± 0.778^a	3.44 ± 0.820^b	Not unique – unique to suweg
Overall	3.28 ± 0.890^a	2.84 ± 0.850^b	2.48 ± 0.918^b	Dislike – like

Data was expressed as mean ± SD. F_{1-3} are syrup formula with 0.6%; 2%; and 4% extracts respectively. Supercribts of different letters show significant differrence between syrup formulas.

As can be seen in Table 3, there are real for the two of the sensory parameters of F_1, F_2, and F_3 syrups, while the other two parameters have no significant differences. Sweetness is a taste distinctive to syrup. According to Kumalaningsih *et al.* (2005) the taste of a food can be derived from the food itself, but if it underwent certain treatment and processing it seems to be influenced by the substances added during processing. The sweet taste of syrup in this study did not differ considerably between treatments because it came from the consistent amount of sugar to each treatment. Sugar used in the manufacture of syrup provides sweetness and an ideal flavor. This is in accordance with the opinion of Pratama *et al.* (2012) that sucrose functions a great deal as a sweetener that can improve consumers' preference towards the taste of a food. The EFY extract used in the treatment tended not to influence the sweet taste of the syrup because of the suspected low sugar content in the extract. This is in accordance with the opinion of Santosa *et al.* (2002) which stated that the EFY has a low sugar content that is between 0 to 2.3 mg/g of fresh weight. According to Susanto and Setyohadi (2011) the flavor of the syrup is influenced by its constituent composition such as essence, sweetener, preservative, and the concentration of the acid component.

Color is a very important component in determining the quality or degree of desirability of a food. According Winarno (2004) whether the process of creating the syrup is of a high quality or not can be characterized by the uniformity and distribution of color in the syrup. The EFY extract syrup in this study did not show any difference between treatments in terms of color. The addition of strawberry essence to the treatment tends to affect the color of the syrup and turn it into red. This is in accordance with the opinion of Murrukmihadi *et al.* (2011) in his study of hibiscus syrup that the addition of orange essence can affect the color of syrup and turn it into orange.

The aroma of syrup in this study was significantly different between treatments. The smell of syrup is obtained from EFY extract that has a very distinct aroma. This is in accordance with the opinion of De *et al.* (2010) that the EFY extract naturally has a distinctive aroma. The increased concentration of extract used will also increase the strength of the aroma. According to Singh and Wadhwa (2017) the distinctive aroma of EFY is derived from the polyphenol component, one of which flavonoids, that can affect the quality of the aroma in food products.

Sensory test results on the overall preferences of EFY extract syrup with three different concentrations of extract showed significantly different results. The three results are on a scale of dislike to like. Preference of EFY syrup is influenced by the combination sensory attributes of color, taste, and aroma. According to Mukarramah *et al.* (2016) the level of consumer preference is influenced by the organoleptic properties of a product which include color, taste, and oral stimulation. Results may differ because each individual panelist may have preferences of their own. Shofiati *et al.* (2014) argued that overall evaluation of the product becomes very important to determine the level of consumers' preference of a food product.

4. CONCLUSION

The increased concentration of the extract used increases the antioxidant activity, pH value, viscosity, aroma, and overall syrup favorability. Thus, the best-formulated syrup based on this study is syrup with an extract concentration of 4% as it has the highest antioxidant activity. However based on sensory properties test, syrup with an extract concentration of 0.6% is the most preferred. EFY *(Amorphophallus paeoniifolius)* irrefutably, therefore, has the potential to be developed as a quality local beverage for its qualified supplementation antioxidant content as a healthy drink in the form of syrup.

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