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Original Paper

Application of Foam Mat Drying in the Making of Herbal Powder

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***Abstract*— The increasing demand for herbal raw materials in Indonesia is evidenced by data according to Riskesdas in 2010-2018 increased by 44.3%. The data also states that 59.12% of Indonesians still consume herbal medicine and 95.6% know the benefits of herbal medicine. The herbal drink consists of various spice mixtures. Commonly used spices consist of ginger, aromatic ginger and lemongrass. Ginger contains gingerol active compounds with antioxidant activity above vitamin E and α-tocopherol. Aromatic ginger contains phenol chemical compounds as antioxidants that are analgetic. Lemongrass contains bioactive compounds as antioxidants. Generally, herbal products are processed in liquid form so that they have a low shelf life, and are easily damaged and contaminated. Therefore, there is a need for innovation in making herbal drinks into powder with the *foam mat drying* method using a *microwave*. The process of making herbal powder is added with tween® 80 and maltodextrin. This study aims to determine the effect of foaming agents and fillers on the organoleptic and physicochemical characteristics of herbal powder, yield value, antioxidant activity and mass balance of the selected treatment. This study used RALF with 2 factors consisting of the ratio of fillers and foaming agents. This study used organoleptic test parameters and physicochemical tests. Results The determination of the selected treatment (organoleptic test) is analyzed for its mass balance and antioxidant activity. The results showed that the addition of the ratio of foaming agents and fillers had a significant effect on organoleptic and physicochemical test characteristics. The herbal powder selected based on the *Spider Web* test is an A1B2 treatment with a yield value of 11.85% and antioxidant activity of 69.6%. The calculated mass balance results in an efficiency value of no more than 1 (100%) and the largest mass loss in the drying process of 577.72 gr or 88.05% of the incoming material.**

Keywords: Herbal powder, Maltodextrin, Tween® 80, Foam Mat Drying, Microwave.

I. INTRODUCTION

Indonesia is a repository of biodiversity that conserves more than 239 types of food crops and more than 2,039 types of medicinal plants that are beneficial for health and alternative medicines from various types of human diseases[1]. In the field of biopharmaceutical industry, the demand for raw materials for traditional herbal plants from year to year is increasing. This is evidenced by Riskesdas data from 2010 to 2018, people who use traditional health efforts increased by 44,3%. Riskesdas data in 2018 shows that 59,12% of Indonesians still consume herbal medicine and 95,6% of herbal consumers know the benefits of herbal medicine for health [2].

Traditional herbal drinks are always in demand because they are believed to be efficacious for health. The type of spice that is often used, ginger, contains active gingerol compounds with antioxidant activity above vitamin E and α-tocopherol. Aromatic ginger contains phenol chemical compounds as antioxidants that are analgetic. Lemongrass contains bioactive compounds such as antioxidants, anti-diabetics and others. The recommended formulation of traditional herbal syrup is with a weight treatment of aromatic ginger 125 gr, ginger 250 gr, lemongrass 125 gr and a weight ratio of brown rice to white rice (4:1) of good quality that meets SNI quality standards [3]. However, processing with this method has the disadvantage of low shelf life and perishable/contaminated products. This problem can be overcome by processing traditional herbal syrup into herbal powder [4].

The *Foam mat drying* method is made from dough with a mixture of filler (Maltodextrin) and foaming agent (Tween® 80)[5]. The dough is poured into a baking sheet or container which is then dried in the microwave. Then, the dried dough proceeds with a siege process to crush it into powder. Tween® 80 produces foam properties that support the stability of the resulting foam structure, adds foam volume and is recognized as a safe food additive (GRAS). Maltodextrin forms a thin film that can speed up the drying process and minimize the occurrence of thermal degradation of active components in the product[6]. Therefore, this research aims to determine the best formulation for herbal powder with variations of Tween® 80 and Maltodextrin using the *foam mat drying* method based on organoleptic and physicochemical characteristics at the best treatment, and then to proceed the calculation of mass balance and antioxidant activity.

II. MATERIALS AND METHOD

A. *Materials*

Tools used include knives, basins, cutting boards, spoons, digital balances, Philips HR 2115 blenders, beaker glass, measuring cups, test tubes, filter cloths, volume pipettes, glass funnels, refrigerators, ziplock plastics, erlenmeyer flasks, hot plates and stirrers, magnetic stirrers, baking pans, spatulas, Maspion MT 1150 hand mixers, test tubes, vortexes, pots, stoves, stirrers, whatman filter paper no 41, 400 watt microwave, centrifuge, refractometer, desiccator, oven, mobile phone, laptop, stopwatch and SPSS software version 25.

Ingredients used are ginger, aromatic ginger, lemongrass, aquades, cardamom, cloves, cinnamon, salt, lime, maltodextrin, tween® 80, buffer 4, buffer 7, DPPH solution and granulated sugar.

B. *Research*

This study used a Factorial Completely Randomized Design (RALF) with 2 factors. The factor consists of the ratio of foaming (Tween® 80) (0,3% and 0,5%) to the ratio of filling material (Maltodextrin) (12,5% and 15%). The number of treatments produced was 4 treatments and repeated 3 times in each treatment. The combination of treats and codes used is in Table 1:

TABLE I. COMBINATION OF HERBAL POWDER SAMPLE TREATMENTS

B (Tween® 80)	A (Maltodextrin)	
	A1(12,5%)	A2(15%)
B1(0,3 %)	A1 B1	A2 B1
B2(0,5%)	A1 B2	A2 B2

C. *Research Stage*

Herbal Extract

Raw materials weighed with a weight of ginger 125 gr, aromatic ginger and lemongrass 62,5 gr. Then the spices are peeled, washed and mashed using a blender by adding aquades 500 ml. Next, the solution is filtered and precipitated for 30 minutes. The result of a solid precipitate is separated by a liquid solution. Next, the liquid solution is treated by adding supporting materials. The supporting ingredients added are 5 grams of cardamom and cinnamon; 2,5 gr cloves; 1 gr of salt and 2 ml of lime. First, the supporting materials are roasted for 2 minutes. Then it is mixed with a liquid solution that has been heated for 2 minutes. Liquid solution plus salt and reheated for 3 minutes. After adding lime juice and stirring until evenly mixed.

Herbal Powder

Herbal powder is made from the addition of the ratio of maltodextrin and tween® 80 by *foam mat drying* method. All ingredients are stirred using a mixer until foaming. Then, the dough is dried for 25 minutes in the *microwave* and stirred once every 1 minute. The dough that has been dried is mashed using a blender to produce a finer powder.

D. *Analysis Procedure*

Organoleptic Test

Organoleptic (hedonic) tests are used to determine the selected treatment. The determination of the selected treatment is taken from the results of questionnaires that have the highest value and analyzed using the *Spider Web* method.

Physicochemical Test

The resulting herbal powder is analyzed to determine its physicochemical characteristics. Physical characteristics consist of solubility tests (Susanti &; Putri, 2014); soluble speed tests (Modification of Yuwono and Susanto 2001); hygroscopicity tests (GEA Niro Research Laboratory, 2005) and water absorption tests (Traina, M.S. and Breene, 1994 in Nurrahman, 2020). Chemical characteristics include water content tests (AOAC, 2012); pH tests (Angelina, 2017) and total dissolved solids tests (Ahh et al., 2014).

Mass Balance and Antioxidant Activity

The calculation of mass balance, yield value and antioxidant activity is carried out on the selected formulation. Formulation determination is obtained from parameter evaluation, namely organoleptic tests. Next, the calculation of mass balance, yield value and activity value of antioxidant content is carried out.

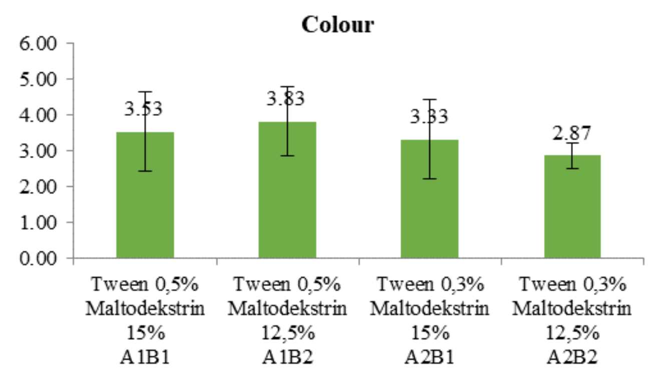
E. *Data Analysis*

The results of research on organoleptic test characteristics were statistically analyzed using the Friedman test and physicochemical tests using ANOVA variety analysis with the help of SPSS software. If there is a significant difference in treatment continue with Duncan's New Multiple Range Test (DMRT) analysis at P ≤0,05.

III. RESULTS AND DISCUSSION

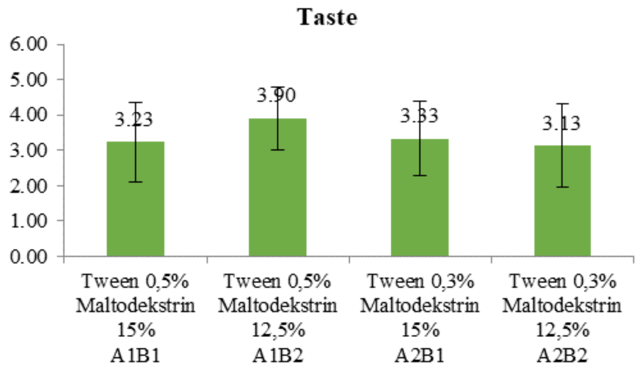
A. *Analisis Organoleptik*

Colour



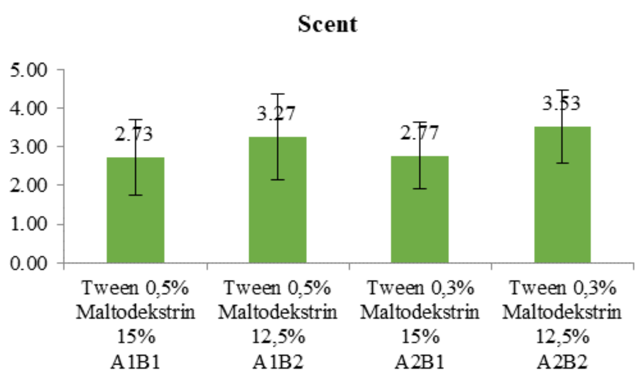
The average value of color favorability test results ranged from 2,87-3,83. Analysis using the Friedman test showed an Asymp.sig value of 0,00<a0,05 showing a difference in the ratio of tween® 80 and maltodextrin had a significant effect. The higher the addition of tween® 80 results in a lighter powder color. The addition of a higher tween® 80 ratio can speed up the drying process and thicken the protective layer contained in the foam dough[8]. The higher addition of maltodextrin also results in a lighter color of the drink. This is because maltodextrin is protective and increases the surface area of the material to speed up the drying process but no *browning/Maillard* reaction occurs [7]. \

Taste



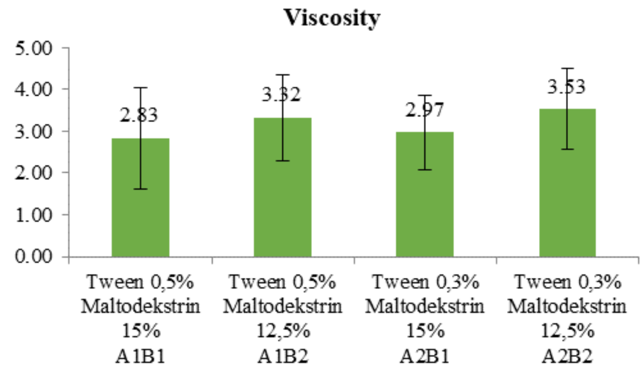
The average value of the taste favorability test results ranged from 3,13-3,90. Analysis using the Friedman test showed an Asymp.sig value of 0,01<a0,05 indicating that the difference in the ratio of maltodextrin and tween® 80 had a significant effect. The taste produced from the powder of a drink that has been brewed with warm water is sweet on the first taste and spicy on the second taste or some time after it is tasted. The spicy taste in instant herbal powder drinks is produced from the ingredients in the form of gingerol and shogaol. The addition of a larger concentration of tween® 80 will thicken the protective layer (film) in the foam dough and the content can be prevented from deterioration during the drying process[9]. The sweetness comes from the addition of sugar and maltodextrin. It is consistent with the literature [10] that maltodextrin comes from a mixture of oligosaccharides and simple sugars that produce a slightly sweet taste. In addition, maltodextrin is one of the encapsulant materials used in powder manufacturing that can reduce the evaporation of volatile compounds in the material.

Scent



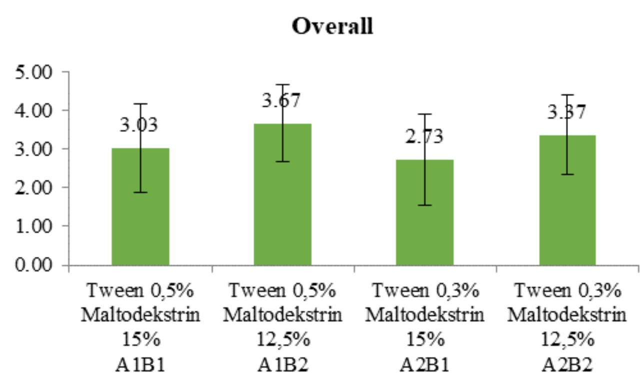
The average value of the scent favorability test results ranged from 2,73-3,53. Analysis using the Friedman test showed an Asymp.sig value of 0,01<a0,05 indicating that the difference in the ratio of maltodextrin and tween® 80 had a significant effect. The higher addition of tween® 80 will produce a stronger aroma of spices. Tween® 80 binds to maltodextrin forming a protective layer in the form of a foam/foam system. The higher the concentration of tween® 80 added, the higher and more stable the foam produced. Abundant and stable foam can protect bioactive components during the processing process[11]. The higher the addition of maltodextrin also produces a stronger aroma of spices. This is because maltodextrin is an encapsulated material that can reduce the evaporation of volatile compounds in the material [12].

Viscosity



The average value of viscosity favorability test results ranges from 2,83-3,53. Analysis using the Friedman test showed an Asymp.sig value of 0.01<a0.05 indicating that the difference in the ratio of maltodextrin and tween® 80 had a significant effect. The higher the addition of tween® 80 produces a thicker herbal drink. The viscosity level produced by this drink is influenced by the characteristics of tween® 80. Tween® 80 is classified as a viscous liquid with a viscosity value of 300-500 centistokes, yellow in color and very soluble in water [13]. The higher addition of maltodextrin results in a greater level of viscosity of the drink. This is because maltodextrin is a humectant, which can bind water but has a low Aw, because it can bind this water, it can be used in regulating the viscosity of a product as desired. In wet products, maltodextrin can act as a thickener[9].

Overall

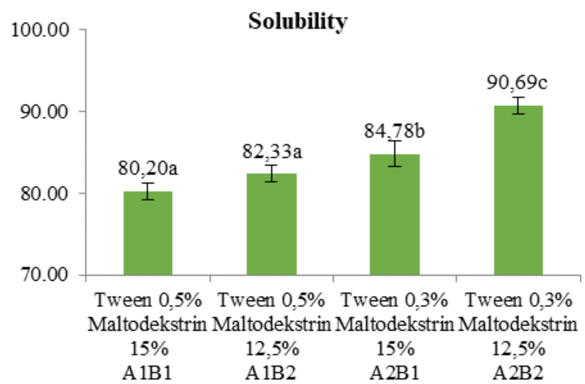


The results of analysis using the Friedman test showed an Asymp.sig value of 0,02<a0,05 indicating that the difference in the ratio of maltodextrin and tween® 80 had a real effect. Factors that influence the overall value results include color, aroma, taste and overall product. The A1B2 treatment was preferred by the panelists over the other treatments. Due to the high addition of maltodextrin produces a young color of herbal

powder. The average panelist prefers the typical brownish color of herbal medicine. In addition, the A1B2 treatment produces a drink taste that is not too spicy, the aroma of herbal medicine is strong but does not cause an unpleasant odor or taste odor and the appropriate level of viscosity.

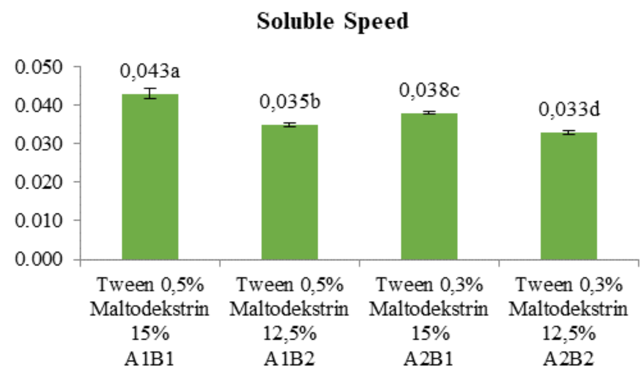
B. Analisa Fisikokimia

Solubility



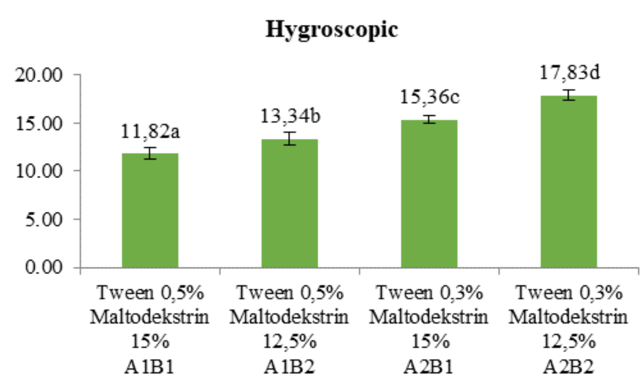
The results of ANOVA analysis with a significance level (P<0,05) showed that the ratio factor of adding tween® 80 and maltodextrin had a significant effect on the solubility value results. The solubility value increased along with the addition of the number of tween® 80. This is due to tween 80 being hydrophilic. The higher the addition of tween® 80, the more bonds are formed between the product and water due to the presence of a free hydroxyl group from oxyethylene. Tween® 80 has an HLB value of 15 which can function as a foam-forming agent and tends to dissolve in water[14]. The higher ratio of the addition of maltodextrin can increase the solubility value of the product. Increased solubility value because maltodextrin has amino groups and hydroxyl groups that can bind hydrophobic substances, have low molecular weight, simple structure, strong binding and are classified as a type of polysaccharide that is very soluble in water. If the solubility value is higher, the better quality of the product, because the brewing process will be easier. If the solubility value is higher, it will result in better product quality, because the brewing process will be easier[15]. The results of the solubility of herbal powder are supported by the results of research [17] that the solubility of passion fruit powder drinks increases along with the addition of tween® 80 concentration with solubility ranging from 70,52-81,39%.

Soluble Speed



The results of ANOVA analysis with a significance level (P<0,05) showed that the ratio factor of adding tween® 80 and maltodextrin had a significant effect. The value of the soluble speed of herbal powder decreases with the increase of tween® 80. This is due to tween® 80 which is classified as a non-ionic surfactant and is hydrophilic with an HLB value of 15. The hydrophilic properties of tween® 80 come from the presence of hydroxyl and oxyethylene groups. These groups result in surfactants being able to form hydrogen bonds with water molecules. The higher the addition of tween® 80 hydrogen bonds formed the more so that the time needed for the powder to dissolve is less [16]. The higher addition of maltodextrin results in a shorter powder dissolution time. This happens because maltodextrin has a hydrophilic hydroxyl group. In addition, maltodextrin is a polysaccharide that is very easily soluble in water, so can form an evenly dispersed solution system. The higher the value of the soluble speed obtained, the better the quality of the product because the brewing process will be faster [7].

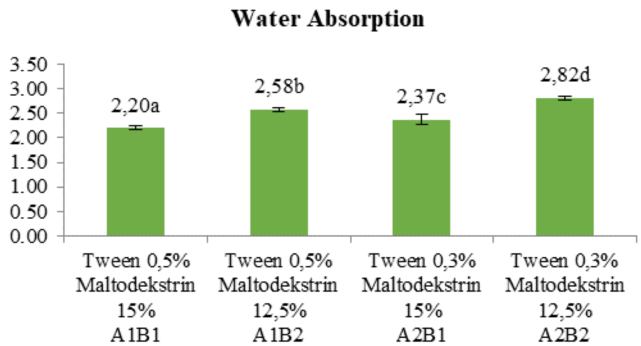
Hygroscopic



The results of ANOVA analysis with a significance level (P<0,05) showed that the addition factor of tween® 80 and maltodextrin with different ratios had a real effect. The higher tween® 80 added can increase the hygroscopic value in herbal powder. Tween® 80 is hygroscopically caused by the free hydroxyl group of oxyethylene so that the OH group in the powder is bound a lot by tween® 80. Tween® 80 has an HLB value of 15 which can function as a foam-forming agent and tends to dissolve in water. The addition of tween® 80 to the product results in a lower moisture content value. Low moisture content indicates a high hygroscopicity value[17].

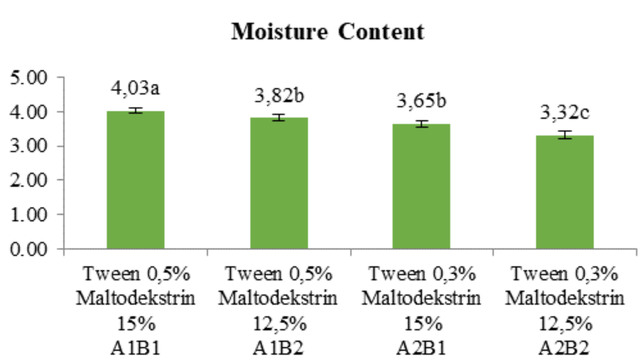
Increased hygroscopic level along with the addition of maltodextrin concentration. Maltodextrin added in the manufacture of herbal powder has a fairly high *dextrose equivalent* (DE) value, namely DE (11-12). The higher the DE value added, the more starch is converted to dextrose, and the higher the reduced sugar content. More reducing sugars will increase the ability of maltodextrin to bind free water to the product increases because reducing sugars have free hydroxyl groups [18].

Water Absorption



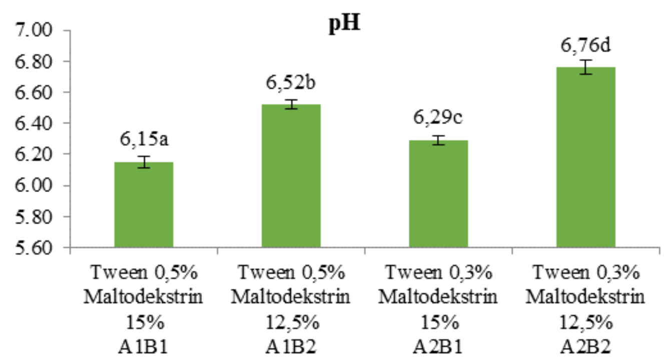
The results of ANOVA analysis with a significance level ($P<0,05$) showed that the addition factor of tween® 80 and maltodextrin with different ratios had a real effect. The higher tween® 80 added can increase the water absorption value of herbal powder. Tween® 80 is hydrophilic, that is soluble in water. The hydrophilic part of the emulsifier has a water-compatible group because it has a part that is polar and binds to water as well as water-soluble molecules. The higher the addition of tween® 80, the porosity of the material will increase and the material absorbs water more easily[19]. Increased water absorption value with the addition of maltodextrin. The higher the concentration of maltodextrin, the greater the number of hydroxyl groups that can bind water from the environment and the reabsorption of water vapor increases. This is caused by the group of maltodextrin which is hydrophilic so that the ability to bind water from the air will be fast. Water absorption affects solubility, where the higher the water absorption of a product, it will have a good solubility value [20]. These results are better than the results of the study [36] with the absorption value of instant soy milk powder of 1,46–1,68 ml / g.

Moisture Content



The results of ANOVA analysis with a significance level ($P<0,05$) showed that the variation factor in the ratio of maltodextrin and tween® 80 had a real effect. The moisture content produced by herbal powder decreases frequently with increasing tween® 80 additions. In one molecule of tween® 80 there are 2 sides, namely hydrophilic and hydrophobic which are classified as non-ionic surfactants. The stirring process causes the movement of hydrophobic groups towards the air so that they attracts with air, while the hydrophilic groups of surfactant molecules attract with water on the material and gas or air which is trapped in a thin layer and forms foam. The foam formed provides a porous structure and enlarges the surface area of the material so that the transportation process of water evaporation in the material becomes easier because the liquid passes through the dry foam structure more easily than layers that have a dense structure of the same material [21]. The higher addition of maltodextrin also causes the moisture content value to decrease. This is due to the addition of maltodextrin binding to tween® 80 so that the evaporation process will be faster and the moisture content in the product decreases. The ability of maltodextrin to bind free water in food products is influenced by the number of hydrophilic hydroxyl groups and the molecular mass of a filler. The water content bound by maltodextrin is more volatile in the drying process than the water content in the tissue because maltodextrin has a lower molecular weight (less than 4000) and a simpler molecular structure [22]. The moisture content value produced by herbal powder has met SNI 01-4320-1996 standards concerning traditional powder drinks, namely with a maximum water content standard of 5%.

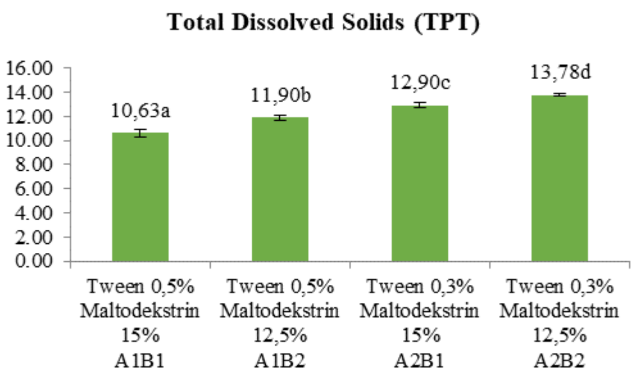
pH



The results of ANOVA analysis with a significance level ($P<0,05$) showed that the addition factor of tween® 80 and maltodextrin with different ratios had a real effect. The higher tween® 80 is added, the pH produced tends to be close to neutral. This is due to the pH of tween® 80 which tends to be neutral, which is more than 6. So the higher tween® 80 added will increase the pH value obtained [23]. The largest component of raw materials added in herbal powder is ginger. [24] states that ginger contains phenolic compounds in the form of zingiber, gingerol, zingerone, shogaol and vitamin C. With the addition of maltodextrin which contains oligosaccharides, the sour taste in herbal powder is reduced because the content of vitamin C in ginger can be neutralized. Oligosaccharides are compounds that have a lot of hydroxyl

(OH) groups so that they can neutralize acidic properties. The pH test results obtained must be acidic, namely pH ranging from 6-6,8 because it can affect the quality of the powder taste. The herbal powder has a fairly good acidity level so it is safe for consumption on an empty stomach [15].

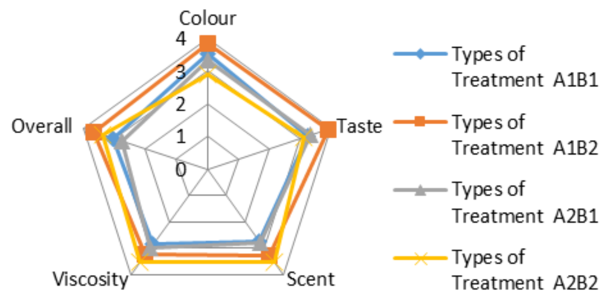
Total Dissolved Solids (TPT)



The results of ANOVA analysis with significance level (P<0,05) showed that the addition factor of tween 80 and maltodextrin with different ratios had a real effect. The higher the tween 80 added, the higher the total dissolved solids in the powder drink. This is because tween® 80 has a high HLB value of 15 (>11). The HLB value describes the solubility properties of a material. Materials that have a high HLB value are hydrophilic, which easily bind water. The presence of free hydroxyl groups and oxyethylene in tween® 80 causes the total dissolved solids to increase as more materials are bound in water [25]. The higher addition of maltodextrin results in an increased total value of dissolved solids. The higher addition of maltodextrin increases the concentration of solutes because the substance is composed of free hydroxyl groups that can bind with water so that they are easily soluble in water. The more free hydroxyl groups in the filler, the higher the solubility level which causes the total dissolved solids to increase. A high total dissolved solids will minimize the formation of deposits because the particles bound by maltodextrin are also increasing [26]. This is also supported by research[37] on making lemongrass instant powder drinks using the foam mat drying method, which reported that the higher concentration of maltodextrin and tween® 80 caused the total dissolved solids to increase, while the total dissolved solids obtained in lemongrass instant drinks ranged from 9,15-13,5°Brix.

C. *Determination of Selected Treatment*

The determination of the selected treatment of herbal powder comes from the results of organoleptic (hedonic) tests that have been obtained. The method used in determining the selected treatment is the *Spider Web* method. The data below is a table of selected treatment analysis results.



A1B2 treatment is the best treatment based on the results of *Spider Web* test data. The majority of the red lines produced by the A1B2 treatment of the *Spider Web* method lie outermost. This shows that the A1B2 treatment has the highest value compared to other treatments. The A1B2 treatment produced the highest color, taste and overall values compared to other treatments with consecutive results of 3,83; 3,90 and 3,67. Overall, consumers like A1B2 treatment drinks because they produce attractive colors, sweet drink tastes, and herbal aromas that are not too strong and not too high viscosity.

D. *Mass Balance*

A mass balance is an event where a material undergoes a physical or chemical change or both with the amount coming in equal to the amount going out. The mass balance is classified as a quantitative calculation by counting all the material that enters, exits, accumulates and is wasted. In a processing process, the amount of material that enters will be equal to the amount of material that comes out [27].

TABLE II. MASS BALANCE OF THE HERBAL POWDER MANUFACTURING PROCESS

No	Process	Input	Output
1.	Process of weighing	Ginger = 125 gr Aromatic ginger = 62,5 gr Lemongrass = 62,5 gr	Ginger = 125 gr Aromatic ginger = 62,5 gr Lemongrass = 62,5 gr
	Total	**250 gr**	**250 gr**
2.	*Trimming*	Ginger = 125 gr Aromatic ginger = 62,5 gr Lemongrass = 62,5 gr	Ginger = 112,63 gr Ginger peels = 12,34 gr Aromatic ginger = 58,21 Aromatic ginger peels = 5,37 gr Lemongrass = 52,04 gr Lemongrass stems = 9,41 gr
	Total	**250 gr**	**250 gr**
3.	Washing Process	Ginger = 112,63 gr Ginger water = 249,76 gr Aromatic ginger = 58,21 gr Aromatic ginger water = 150,24 gr Lemongrass = 52,04 gr Lemongrass water = 150,37 gr	Ginger = 118,49 gr Water+dirt that ginger = 246,84 gr Aromatic ginger = 59,31 gr Air+ dirt that aromatic ginger = 145,93 gr Lemongrass = 53,80 gr Air+ dirt that lemongrass = 148,88 gr
	Total	**773,25 gr**	**773,25 gr**
4.	Downsizing 1	Ginger = 118,49 gr Aromatic ginger = 59,31 gr Lemongrass = 53,80 gr	Ginger = 118,49 gr Aromatic ginger = 59,31 gr Lemongrass = 53,80 gr
	Total	**231,60 gr**	**231,60 gr**

No	Process	Input	Output
5.	Extraction Process	Ginger = 118,49 gr Aromatic ginger = 59,31 gr Lemongrass = 53,80 gr Water extraction = 500 gr	Herbal extract = 721,92 gr Loss produk = 9,68 gr
	Total	**731,60 gr**	**731,60 gr**
6.	Filtration Process	Herbal extract = 721,92 gr	Herbal extract = 662,84 gr Herbal dregs = 43,35 gr Loss product = 15,73 gr
	Total	**721,92 gr**	**721,92 gr**
7.	Deposition Process	Herbal extract = 662,84 gr	Herbal extract = 651,77 gr Herbal deposits= 10,63 gr Loss product = 0,44 gr
	Total	**662,84 gr**	**662,84 gr**
8.	Process of Heating	Herbal extract = 651,77 gr Cardamom = 5,02 gr Cinnamon = 5,07 gr Capsules = 2,50 gr Salt = 1 gr Limeade= 2 gr	Herbal extract = 598,49 gr Dregs = 17,35 gr Water steam = 51,52 gr
	Total	**667,36 gr**	**667,36 gr**
9.	Mixing process	Herbal extract = 598,49 gr Maltodextrin = 73,69 gr Tween® 80 = 2,95 gr	Sample = 656,12 gr Loss product = 19,01 gr
	Total	**675,13 gr**	**675,13 gr**
10.	Draining process	Sample = 656,12 gr	Crude Powder = 78,4 gr Water steam = 567,71 gr Loss product = 10,01 gr
	Total	**656,12 gr**	**656,12 gr**
11.	Downsizing 2	Crude Powder = 78,4 gr	Fines Powder = 77,77 gr Loss product = 0,63 gr
	Total	**78,4 gr**	**78,4 gr**
	SUM TOTAL	**5.035,45 gr**	**5.035,45 gr**

E. Efficiency Value

Efficiency is the concept of no wasted resources. Efficiency can be concluded in a process using minimal raw materials and producing the maximum product. The efficiency value is said to have a maximum value of 1 (100%)[28].

TABLE III. THE RESULT OF CALCULATING THE EFFICIENCY VALUE OF HERBAL POWDER.

No	Process	Efficiency Value	(%)
1.	Process of Weighing	1	100
2.	*Trimming*	0,733	73,27
3.	Washing Process	0,300	29,95
4.	Downsizing 1	1	100,00
5.	Extraction Process	0,987	98,68
6.	Filtration Process	0,918	91,82
7.	Deposition Process	0,983	98,33
8.	Process of Heating	0,897	89,68
9.	Mixing process	0,972	97,18
10.	Draining Process	0,119	11,95
11.	Downsizing 2	0,992	99,20

The process that has the greatest efficiency value is in the weighing and reducing process size 1 (100%), this can occur because the input and output are the same value. While the main process of making powder has an efficiency value of 0,119 (11,95%). The efficiency value of the drying process is relatively low due to the input of materials which are mostly in the form of water while the output produced is in the form of powder. The water in the material evaporates during the drying process due to exposure to *microwave* heat.

F. Mass Loss Value

The difference in the amount of input and output produced is called mass loss. Mass loss value in the production process can be known by calculating the number of inputs and outputs in each process. The largest mass loss value was found in the drying process, which was 577,72 gr (88,05%). Mass loss in this process results from heat in the microwave which converts the material into powder form and the water in the material evaporates.

TABLE IV. MASS LOSS CALCULATION RESULTS IN EACH HERBAL POWDER PROCESSING PROCESS.

No	Process	Mass Loss (gr)	(%)
1.	Process of Weighing	0	100
2.	*Trimming*	66,820	73,27
3.	Washing Process	541,650	70,06
4.	Downsizing 1	0	100
5.	Extraction Process	9,680	1,32
6.	Filtration Process	59,080	8,18
7.	Deposition Process	11,070	1,67
8.	Process of Heating	68,870	10,32
9.	Mixing process	19,010	2,82
10.	Draining Process	577,720	88,05
11.	Downsizing 2	0,630	0,08

G. Yield

Yield is a large percentage of material left behind. The yield produced in this study was obtained from the comparison between the herbal powder produced with the weight of fresh ingredients in the selected treatment, namely the A1B2 treatment. A good yield is to have a value of more than 10%[34]. It can be said that the yield of herbal powder obtained in the selected treatment A1B2, which is 11,85%, is classified as good because it has exceeded the minimum requirements.

The increased yield value is affected by the addition of tween® 80. Tween® 80 can bind to maltodextrin and increase TPT because maltodextrin is a hydrophilic compound (binds water) and can bind lipophilic substances. Binding tween® 80 will increase the amount of powder yield produced as more components of the material are bound in the filtrate[29]. Maltodextrin is a food additive in the form of solids, so the addition of maltodextrin can increase the total solids in the material and the weight of the final weight of product after drying increases [20]. The more maltodextrin used, the greater the yield produced. This is because the use of maltodextrin in the powder serves to increase the volume and increase the total solids of the material so that the yield obtained is higher. The resulting increase in total yield indicates that maltodextrin serves as a mass enhancer[30]. This is also supported by research [31] on the manufacture of *nata de coco* powder by *foam mat drying* method, which reported that the higher concentration of tween® 80 can cause the yield to increase, which ranges from 6,38-7,77%.

H. Value Of Antioxidant Activity

The value of antioxidant activity is divided into categories, namely < value of 20% classified as low, 20-0% classified as medium and 50-90% classified as high [32]. The value of antioxidant activity obtained in the best treatment of A1B2 is classified in the high category with a value obtained 69,6%. The value of antioxidant activity is obtained from the raw materials of ginger, aromatic ginger and lemongrass used as well as the ratio of addition of maltodextrin and tween® 80. Ginger contains gingerol, shogaol and zingeron compounds that provide antioxidant effects. Aromatic ginger contains phenolic compounds, flavonoids, cinnamic acid and sineol that can capture free radicals. Lemongrass contains essential oil compounds in the form of saponins, alkaloids and flavonoids which are useful as antioxidants [33].

The higher the concentration of tween® 80 can increase the antioxidant activity of herbal powder. Tween® 80 is a non-ionic surfactant that has hydrophilic and hydrophobic sides in one molecule that can encourage foam formation. During aeration or shuffling, air incorporation occurs into the liquid microstructure which leads to the creation of an interface of water and air to form foam. Increased concentrations of tween® 80 and maltodextrin cause a more protective layer (film) in the foam system so that bioactive compound components such as phenols and flavonoids in the material can minimiz from oxidative damage [7]. Maltodextrin is a food serves to bind active food ingredients or active compounds. The addition of maltodextrin serves to coat flavor components, increase volume, speed up the drying process, prevent damage to ingredients due to heat and improve the organoleptic characteristics of beverages [26]. According to [34] other factors that affect the stability of antioxidants are temperature, light, oxygen, enzyme activity and others. During the processing process, it is suspected that antioxidant activity is in direct contact with the hot temperature in the microwave. Natural antioxidants are generally concentrated liquids and are very sensitive to hot temperatures.

IV. CONCLUSION

The results showed that the addition of the ratio of foaming agents and fillers had a significant effect on organoleptic and physicochemical test characteristics. The herbal powder selected based on the *Spider Web* test is the A1B2 treatment. The herbal powder has a yield value of 11,85% and antioxidant activity of 69,6%. The calculated mass balance results in an efficiency value of no more than 1 (100%) and the largest mass loss in the drying process of 577,72 gr or 88,05% of the incoming material.

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