Medical Sains : Jurnal Ilmiah Kefarmasian
Vol. 9 No. 4, October - December 2024
https://ojs.ummada.ac.id/index.php/iojs

FORMULATION AND CHARACTERIZATION OF INSTANT POWDER COMBINATION OF MILK, YOLK AND TEMULAWAK (*Curcuma xanthorriza* Roxb) TO PREVENT STUNTING

Shandra Isasi Sutiswa[1,2*], Nur Aji[1,2]
[1]*Departement of Pharmacy, Poltekkes Kemenkes Tasikmalaya*
[2]*Center of Excellence (CoE) Health and Disaster Emergency (HADE) Center, Poltekkes Kemenkes Tasikmalaya*
**Email Corresponding: shandra.isasi.si@gmail.com*

Submitted: April 16, 2024 Revised: October 3, 2024 Accepted: November 6, 2024

ABSTRACT

Through its health transformation program, the Ministry of Health has replaced giving biscuits as additional food to toddlers and pregnant women to prevent stunting with animal protein made from local food. Milk and eggs are local food sources of animal proteins that can be processed into nutraceuticals. Another cause of stunting is lack of appetite, nausea, and vomiting in children during pregnancy. Temulawak is a traditional medicine that can improve appetite. A combination of milk, yolk, and temulawak can be formulated for nutraceutical preparation. This study aimed to develop and test the characteristics of instant powder combinations of milk, yolk, and temulawak to prevent stunted growth. The laboratory experimental method was used in this study. The formula was prepared by mixing temulawak extract granules with powder obtained from the freeze-drying process of milk and yolk. There were 3 variations of the combination concentration with a ratio of milk : yolk : temulawak, F1 (40:2:3), F2 (50:3:2), and F3 (60:4:1). The results of the research showed that all formulas had physical characteristics in the form of light yellow powder with a typical ginger aroma, particle size between 119.66–120.39µm, angle of repose between 36.40–44.46°, flow rate between 1.32–1 .34g/sec, specific gravity between 0.44-0.47g/mL, tap density between 0.62–0.68g/mL, compressibility between 13.00-13.33%, pH between 6.45–6, 48, dispersibility time between 02.14 – 02.17 minutes and water content between 3.48 – 4.93% according to SNI-01-2970-2006 instant milk powder. From the research results, it can be concluded that milk, egg yolk, and ginger can be formulated into instant powders to prevent stunting. All formula requirements meet the characteristics of instant powders.

Keywords: instant powder, milk, stunting, temulawak, yolk

INTRODUCTION

Stunting is a physical growth disorder, such as a linear decrease in growth rate; therefore, children fail to grow to reach optimal height potential. Stunting not only interferes with physical growth but can also decrease a child's cognitive and intelligence levels. If not addressed, stunting can further impact the country's development because stunting causes the country's low quality of human resources. The prevalence of stunting in Indonesia in 2022 is still high (21.6%), which is far from the WHO standard of <20%, and the Ministry of Health's stunting reduction target in 2024 is 14% (Oktriani et al., 2022;Primantika and Erika Dewi Noorratri, 2023).

Stunting usually appears in the first 2-3 years of life because of inadequate nutritional intake (Suthutvoravut et al., 2015). During a child's growth and development, a toddler needs high levels of nutrition to support the speed of growth and development to achieve optimal growth (Afriyani et al., 2019). Up to the age of 2 years, nutritional needs can still be met by consuming breast milk according to WHO recommendations; however, after more than 2 years, nutritional needs must be met with family food.

A high incidence of stunting is a concern for the government. One of the causes of stunting is the lack of nutritional intake from when one is in the womb until after birth. Therefore, it is necessary to prevent stunting by providing local nutraceutical supplementary food (PMT). The Director General of Public Health, Ministry of Health of the Republic of Indonesia, at health.detik.com (https://health.detik.com/berita-detikhealth/d-6724907/kemenkes-tak-lagi-berikan-biskuit-untuk-cegah-stunting-ini-gantinya), said that the Ministry of Health is moving quickly to replace the provision of biscuit supplementary food (PMT) for stunted children by increasing animal protein intake with PMT made from local ingredients in the regions.

Milk and eggs are local food sources of animal protein that can be processed into nutraceutical preparations (Jein Rinny Leke et al., 2023). Apart from a lack of nutrition from food, other causes of stunting include a lack of appetite in children as well as nausea and vomiting during pregnancy. *Curcuma xanthorrhiza* is a traditional medicine that can increase and improve appetite, nausea, and vomiting because temulawak contains carminative essential oils. When these carminatives process and stimulate the digestive system, appetite appears (Handayani, 2021). A combination of milk, yolk, and *Curcuma xanthorrhiza* can be formulated as nutraceutical preparations. However, inappropriate formulations can affect product characteristics. This study aimed to develop nutraceutical dosage forms by formulating and testing the characteristics of instant powder preparations of milk, yolk, and *Curcuma xanthorrhiza* to prevent stunting. Milk, yolk, and *Curcuma xanthorrhiza*, which are liquid-based, are made into instant powder preparations to make them more practical in use and durable in storage.

RESEARCH METHODS

Equipment and Materials

The equipment used in this study was a freeze dryer, analytical scales (Sartorius), sieves (standard test sieve, CV. Total Equipment Pharmacy, Indonesia) (mesh 40, mesh 60, mesh 85, mesh 120, mesh 200), pH meter (Sartorius), standard flow characteristic funnel (CV. Mitra Medika Utama solo, Indonesia), measuring cup (Pyrex), Beaker glass (Pyrex).

The materials used in this study were fresh milk, omega yolk, *Curcuma xanthorrhiza* rhizome, and sucrose food grade PT. ATFI, maltodextrin pharmaceutical grade PT. ATFI, sucralose food grade PT. ATFI, and the aquadest pharmaceutical grade PT. Bratachem.

Research Procedure

1. Determination

The determination was performed at Siliwangi University, number 42/UN58.10.6/LL/2024.

2. Formulation of instant powder combination of milk, yolk and temulawak

a) Making Temulawak granules

Temulawak (*Curcuma xanthorrhiza*) granules were conventionally prepared using a crystallization method. *Curcuma xanthorrhiza* rhizomes were first cleaned and then mashed by adding 500 mL of aquadest after draining. Subsequently, it was squeezed and filtered. To make a thickened solution, a mixture of 500 mL of *Curcuma xanthorrhiza* extract and 100 g of sucrose was added until it reached the desired consistency. After it thickens, the stove is turned off, and stirring continues until a crystalline granule mass forms. The *Curcuma xanthorrhiza* extract granules were stored at room temperature until cold and in airtight packaging.

b) Freezy-drying whole milk and yolks

Freeze drying of pure milk and yolks was carried out to change the pure milk and yolks from liquid to dry. Whole milk and yolks were dried using a freeze dryer at -56 ^{O}C until dry.

c) Formulation of instant powder combination of milk, yolk and temulawak

The instant powder formulation from milk, yolk, and *Curcuma xanthorrhiza* is made using dried milk, dried yolk, and *Curcuma xanthorrhiza* granules with excipients of maltodextrin as a filler and sucralose as a sweetener. All ingredients were weighed according to the draft formula in **Table I**, crushed until homogeneous, and sieved using a number 16 mesh sieve. The instant powder from milk, yolk, and *Curcuma xanthorrhiza* was then packaged in an airtight container to avoid humidity.

Table I. Formula of instant powder

Materials	F1 (%)	F2 (%)	F3 (%)	Utility
Milk powder	40	50	60	Active ingredients
Yolk powder	2	3	4	Active ingredients
Temulawak granules	3	2	1	Active ingredients
Sucralose	0,2	0,2	0,2	Sweetener
Maltodektrin ad	100	100	100	Filler

Note:
F 1: Instant powder formula containing (40% milk; 2% yolk; 3% temulawak)
F 2: Instant powder formula containing (50% milk; 3% yolk; 2% temulawak)
F 3: Instant powder formula containing (60% milk; 4% yolk; 1% temulawak)

3. Characterization of instant powder

a) Organoleptic test

The instant powder of milk, yolk, and *Curcuma xanthorrhiza* was observed as a whole using the five senses to determine the shape, color, smell, and taste of the preparation (Ansori et al., 2022).

b) Particle size distribution test

The powder was passed through a series of sieve sizes arranged in layers with the diameter of the finest hole at the bottom. The sieve array was placed on top of the vibrator machine and vibrated for a particular time (5-30 minutes). The vibration time depends on the physical stability of the powder from each sieve. The particles remaining in each sieve were weighed, the percentage and diameter were calculated, and a distribution curve was constructed (Husni et al., 2020;Putu Noviantari et al., 2017).

c) Compresibility test

This test was carried out by weighing 25 grams of the sample (M) into a 100 mL measuring cup and then measuring the volume (V bulk). The measuring cup containing the sample was then tapped 300 times, and the compressed volume (V tap) was obtained. The tap density (BJ) was obtained by dividing M by V, and the bulk density (BJ) was obtained by dividing M by V. The percentage of the powder compressibility index was then calculated (Husni et al., 2020).

d) Flow properties test (flow rate and angle of repose)

Granule powder (100 grams) was weighed and placed in a funnel with the end closed. Prepare a stopwatch to measure the time. The end cap of the funnel was opened, and the stopwatch was run at the same time. The granular powder was allowed to flow until it ran out, noting the time it took for the granular powder to run out of the funnel. The flow rate was calculated by dividing the weight of the granule powder by the time taken to pass through the funnel (g/sec). The angle of repose was determined by measuring the height and diameter of the pile of granular powder that was formed after it had all flowed from the funnel (Husni et al., 2020;Khairunnisa et al., 2016).

e) Water content test

Water content measurements could also be performed using the oven method. A 2 g sample was placed in a closed weighing bottle with a known weight.

Subsequently, it was dried in an oven at 105°C for 3 hours, cooled in a desiccator, and weighed. This work was performed until a fixed weight was obtained. The percentage of water content was obtained by calculating the weight of the granule powder before drying (W0) with the weight of the granule powder after drying (W1) (Husni et al., 2020).

f) Dispersibility test

The dispersibility time of the granule powder was measured by calculating the time required for the granule powder to reach a serving size using a 500 ml Beaker glass. Some granule powders, whose dispersibility time will be measured, are placed in 200 mL of water in a beaker glass, while the time calculation begins using a stopwatch. The granule powder dissolves if there is no more granule powder mass or it has all dissolved. This was indicated by the mixing of the entire granular powder mass into a solution. The dispersibility time of the granule powder was expressed in minutes (Husni et al., 2020).

g) pH test

The test was performed by dissolving 20 grams of powder in 100 mL of water. The pH meter was calibrated first with buffers of pH 6.86, pH 4.01, and pH 9.18, until the instrument showed the pH value. It was then washed with Aquadest and dried with tissue. The pH meter was dipped in the preparation and the instrument was left to show a constant pH value (Husni et al., 2020).

Data Analysis

The research results were analyzed statistically using descriptive analysis methods and compared with the standards of instant powder preparations.

RESULTS AND DISCUSSION

Determination

Based on the results of the plant sample determination carried out at Siliwangi University, the plant was found to be a Temulawak plant with the scientific name *Curcuma xanthorhiza*.

Organoleptic Test

The organoleptic test results showed that the three formulas were in powder form, light yellow, with a distinctive aroma of milk, yolk, and *Curcuma xanthorrhiza*, as shown in **Figure 1**. The yolk was yellow in color. The powder color of F3 was lighter than that of F1 and F2 because the *Curcuma xanthorrhiza* concentration in F3 was lower (1%). This was also caused by the higher concentration of white ingredients in F3, such as milk, sucralose, and maltodextrin, which have a white color (Ansori et al., 2022;Fatmah et al., 2022).

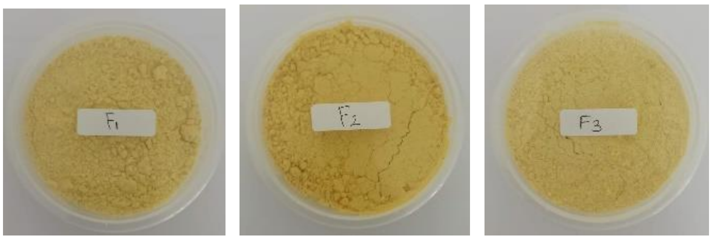

Figure 1. Instant Powder with Varying Concentrations (milk:yolk:*Curcuma xanthorrhiza*) F1 (40:2:3), F2 (50:3:2), and F3 (60:4:1)

All instant powder formulas have a distinctive aroma of ingredients, such as milk, yolk, and *Curcuma xanthorrhiza*. This distinctive aroma was maintained in the form of an identity for the formula. The distinctive aroma of powder F1 was more pronounced because the concentration of maltodextrin added was higher. This is in line with Fatdhilah and Anna's research, which states that maltodextrin can be used to protect the aroma of the formula

(Yuliawaty & Susanto, 2015;Fatmah et al., 2022). The greater the concentration of maltodextrin used in the formula, the better it can retain or protect the aroma of the preparation (Yuliawaty & Susanto, 2015).

Particle size distribution test

Table II. Results of Instant Powder Particle Size Distribution Tests

Formulas		F1			F2			F3		
Mesh Number	**Ø Mesh (d)**	**Lagging weight (g)**	**% W (a)**	**a x d**	**Lagging weight (g)**	**% W (a)**	**a x d**	**Lagging weight (g)**	**% W (a)**	**a x d**
40	425	0.02	0.08	31.88	0.09	0.44	188.70	0.10	0.02	8.16
60	250	0.92	4.61	1152.50	0.61	3.03	757.63	0.78	0.16	39.24
85	180	1.62	8.08	1454.67	2.10	10.50	1890.00	1.93	0.39	69.33
120	125	9.40	47.00	5875.00	9.50	47.50	5937.50	9.70	1.94	242.50
200	75	6.10	30.50	2287.50	6.10	30.50	2287.50	6.40	1.28	96.00
		18.05	90.27	10801.55	18.39	91.97	11061.33	18.91	3.78	455.23
Particle size diameter (µm)		119.66			120.27			120.39		

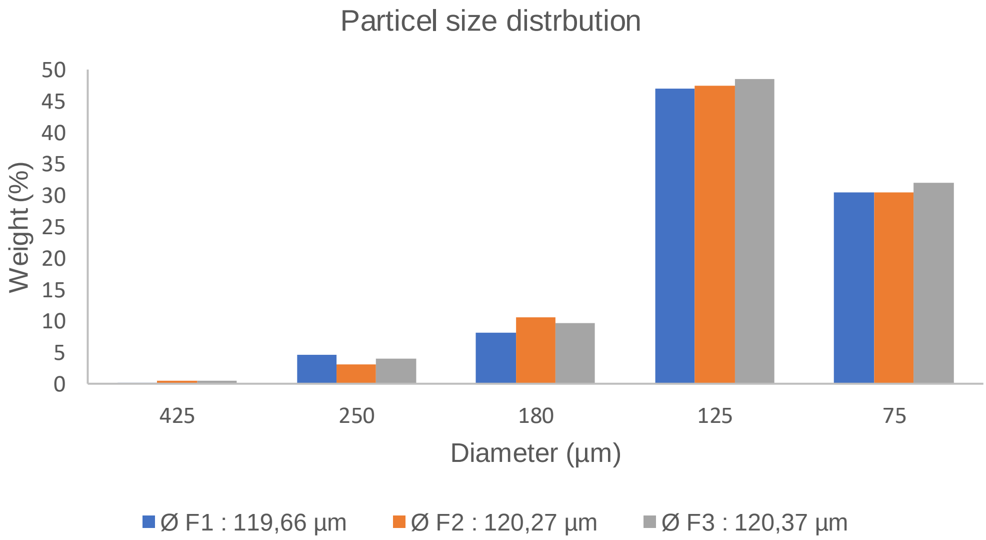

Figure 2. Curve of Instant Powder Particle Size Distribution

The results of the analysis of particle size distribution test data show that each formula has an average particle size diameter that is almost the same as seen in **Table II** where the diameter of F1 (119.66 µm); F2 (120.27 µm) and F3 (120.39 µm). In **Figure 2**, it can be seen that all formulas are distributed over various mesh numbers, which are arranged from the smallest mesh number to the largest diameter. The highest amount of weight remaining on a mesh with a certain diameter indicates that the particle size has a particle diameter within the mesh diameter range. The particle sizes of the three formulas have a uniform diameter because the process for preparing instant powder preparations and the test methods used are the same; the only difference is in the concentration of the active ingredients and excipients used. The average diameter of the three preparations was less than 1 mm, where the smaller the particle size, the greater the surface area, and the greater the contact angle to absorb water, so the faster it dissolves (Putu Noviantari et al., 2017). The particle size of F1 was smaller than those of F2 and F3 because the concentration of maltodextrin used in F1 was higher.

Flow properties and compressibility test

Table III. Results of Bulk Density, Tap Density and % Compressibility Tests

Formulas	ρ Bulk (g/mL)	ρ Tap (g/mL)	% Compressibility
F1	0.46 ± 0.01	0.65 ± 0.03	13.00 ± 1.00
F2	0.44 ± 0.01	0.62 ± 0.04	13.33 ± 1.53
F3	0.47 ± 0.01	0.68 ± 0.04	13.00 ± 1.00

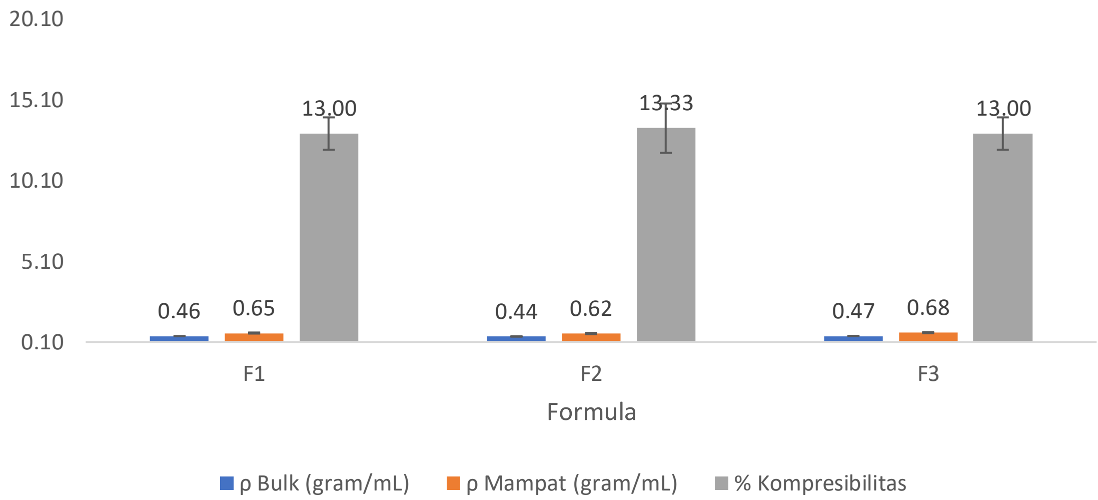

Figure 3. Graph of Bulk Density, Tap Density and % Compressibility

Compressibility tests were performed to determine the decrease in the powder volume due to vibration or impact. The initial powder volume before tapping is called the bulk density, and that after tapping is called the tapping density. The density test data and % compressibility are listed in **Table III**. The smaller the difference between the volumes before and after tapping, the smaller is the compression index (% compressibility). The smaller the % compressibility, the better the flow properties of the powder. The compressibility index is largely determined by the shape and size of the particles, as well as the water content. The shape and size of the powder particles when compressed fill the spaces between the particles (Hilaria & Ristian Octavia, 2020). **Figure 3** shows that the three formulas have varying % compressibility but still meet the requirements for physical powder properties because the % compressibility is less than 20% (Khairunnisa et al., 2016).

Table IV. Results of the Angle of Repose, Flow Rate, Water Content, Dispersibility Time and pH Tests

Formulas	Angel or repose (°)	Flow rate (gram/second)	Water content (%)	Dispersibility time (minute)	pH
F1	44.46±0.93	1.32±0.25	4.93±0.04	2.14±0.02	6.45±0.01
F2	39.67±0.44	1.34±0.31	3.48±0.04	2.16±0.02	6.47±0.01
F3	36.40±0.03	1.33±0.31	3.78±0.06	2.17±0.06	6.48±0.01

The angle of repose is the angle formed between a pile of particles and a flat surface when a certain amount of granular powder is poured or flows through a funnel. The piles of particles formed a cone. If the resulting cone is flatter, the height of the cone will be smaller and the value of the angle of repose will be smaller. The angle of repose is influenced by the shape and size of the particles, as well as the moisture content or water content of the granule powder (Kholidah & Khumaidi, 2014). The angle of repose is related to the flow properties of the granular powder. Granular powder has good flow properties if the angle of repose is < 30°. In **Table IV**, it can be seen that the angle of repose for the three formulas is in the range 36.40 of 44.46°. The angle of repose value for all formulas > 30° indicates that it is difficult for the powder to flow. The smaller the milk concentration, the greater the maltodextrin concentration and the greater the angle of repose of the granule powder (**Figure 4**). This occurs because maltodextrin is hygroscopic; therefore, if the concentration of maltodextrin is greater, the moisture or water content of the powder will be greater. The particle size also affects the value of the angle of repose, because if the particle size is small, the porosity of the powder particles decreases, making it more difficult for the powder to flow. The flow properties can be used as a reference for selecting packaging forms and processes. In addition to being related to the angle of repose, the flow properties are also related to the flow rate of the granular powder.

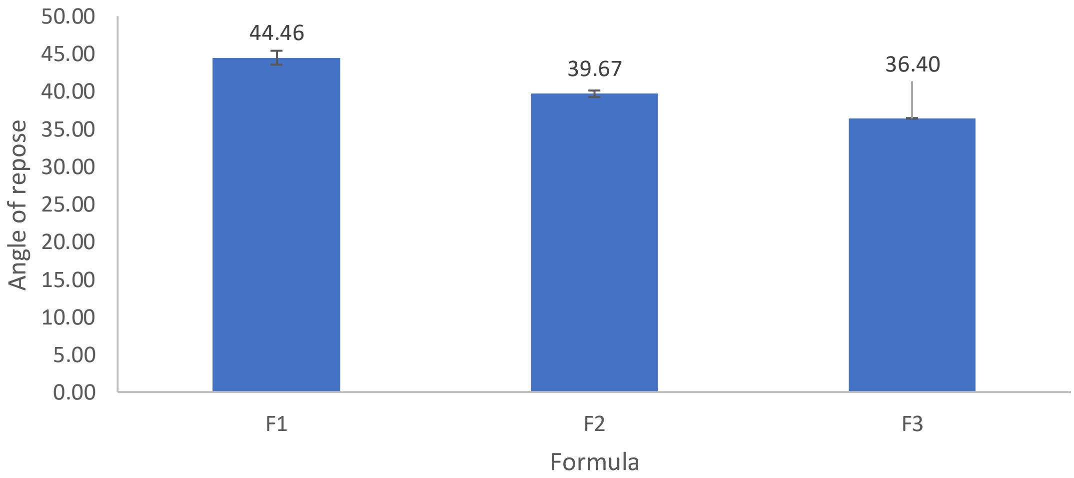

Figure 4. Graph of the Angle of Repose

The flow rate was expressed in grams/second, whereas granular powder was included in the good category if the flow rate was not less than 4 grams/second. The flow rate test results for the three formulas were 1.32 – 1.34 grams/second (**Figure 5**). These results indicate that the flow rate or powder flow properties are included in the poor category (Khairunnisa et al. 2016). As with the angle of repose, the flow rate and flow properties are also influenced by the shape and size of the particles and the granule powder moisture or water content (Kholidah & Khumaidi, 2014). The higher the water content, the smaller the flow rate of the granular powder. This is because the water content in the powder can increase the attractive force between particles, making it difficult for the powder to flow. The flow rate was inversely proportional to the water content of the granule powder. This is proven by the test results of the water content of each formula in **Table IV**.

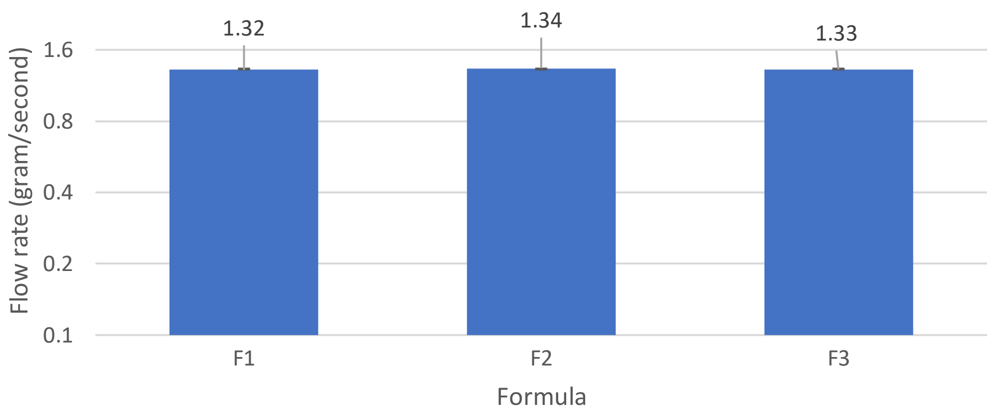

Figure 5. Graph of Flow Rate

Water content test

The water content was tested to determine the % water content in the granular powder. The water content test results of the three formulas were in the range of 3.48 – 4.93%, with the water content values of each formula being F1 (4.93%), F2 (3.48%), and F3 (3.78%). The greater the concentration of maltodextrin in the formula, the greater the water content of the powder because it has hygroscopic properties, which can increase the moisture and water contents of the powder (Fatmah et al., 2022;Yuliawaty & Susanto, 2015). In F2, although the concentration of maltodextrin used is greater than that in F3, the water content in F2 was lower than that in F3. The physicochemical properties of each ingredient in the formula could also have caused this. High water content in instant powder preparations can cause instability of the preparation so that the preparation becomes damaged and the shelf life of the preparation becomes shorter (Amanto et al., 2015). **Figure 6** shows that the water content of all formulas is <5% according to the water content requirements for powdered milk in SNI-01-2970-2006 (Badan Standarisasi Nasional, 2006).

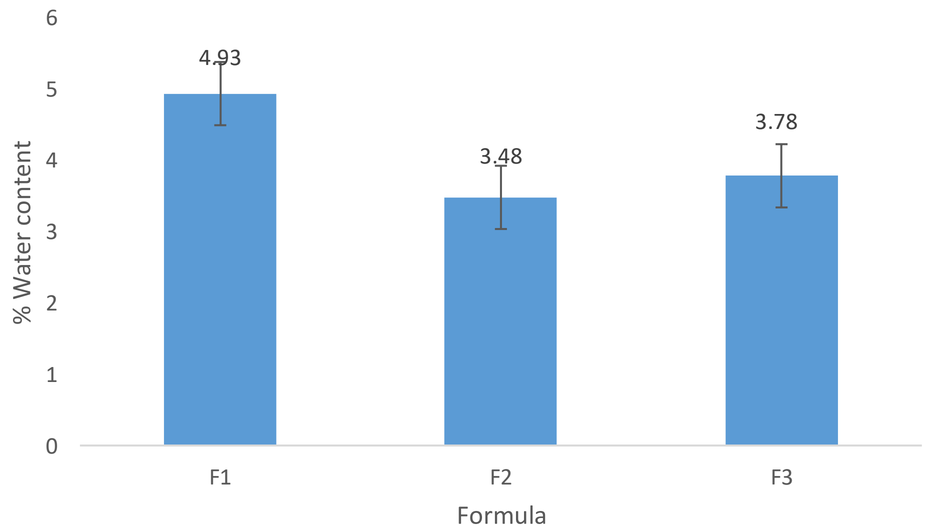

Figure 6. Graph of Water Content

Dispersibility test

Dispersibility time test to calculate the time required for instant powder preparation to dissolve. Dispersibility time is one of the parameters of instant drink powder. The faster the time required to dissolve the powder, the easier it was for the powder to dissolve. However, the longer it takes to dissolve the powder, the lower the solubility of the powder. The higher the water content of the powder, the shorter the dispersibility time. The particle size of the powder or granule preparations was directly proportional to the dispersibility time. The test results for the dispersibility time of each formula in **Figure 7** are F1 (2.14 minutes), F2 (2.16 minutes), and F3 (2.17 minutes). This follows the theory that the smaller the particle size, the greater the solubility and the shorter the time needed to dissolve (**Table IV**). The dispersibility time of the three formulas yielded good results following the dispersibility time requirements for instant powder preparations, that is, less than 5 minutes (Civilization et al., 2021).

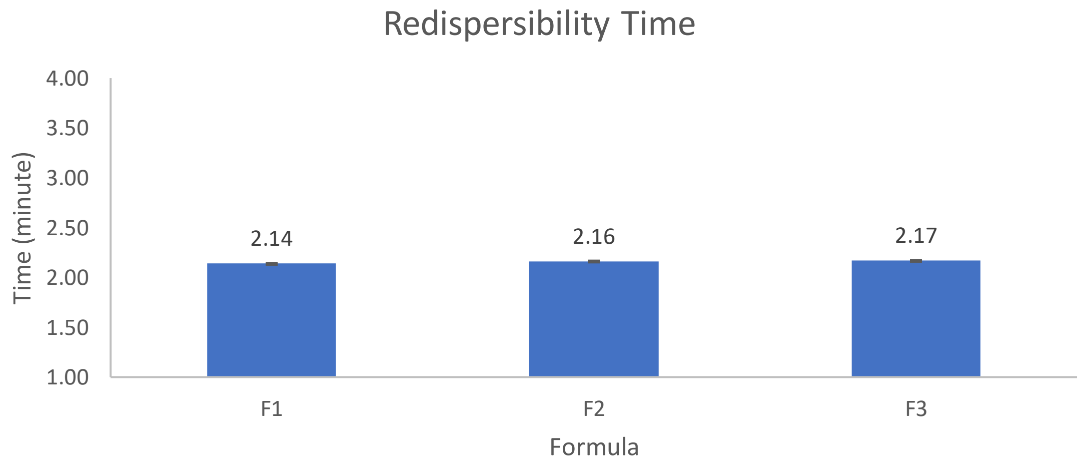

Figure 7. Graph of Dispersibility Time

pH test

A pH test was performed to determine the acidity level of the preparation. The acidity level (pH) of the preparation can affect the physical and chemical stability of the instant powder preparation, which is related to user safety and comfort (Suena et al., 2021). The pH test results for the three formulas vary, as shown in **Figure 8**. The pH of each formula was F1 (6.45), F2 (6.47), and F3 (6.48). This shows that the higher the concentration of maltodextrin in the formula, the smaller the pH value of the preparation, or the pH value is inversely proportional to the concentration of maltodextrin. The low pH value may be caused by maltodextrin, which is the result of starch hydrolysis by acid and still contains acid residues (Yuliawaty & Susanto, 2015). These three formulas can be declared safe because they have a pH range close to neutral or above 5.3. If the pH of the preparation is too acidic or less than 5.3, the stomach can be irritated. If the pH is too alkaline, it can cause a bitter and uncomfortable taste when consuming the preparation (Rahmawati et al., 2016).

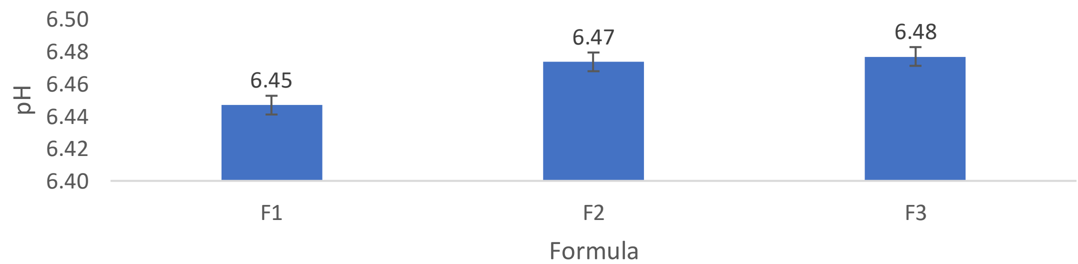

Figure 8. Graph of the pH of Instant Powder Preparations

CONCLUSION

According to research findings, it has been deduced that milk, yolk, and *Curcuma xanthorrhiza* can be combined to create an instant powder that can help prevent stunting. The results of the research showed that all formulas had physical characteristics in the form of light yellow powder with a typical ginger aroma, particle size between 119.66–120.39µm, angle of repose between 36.40–44.46°, flow rate between 1.32–1 .34g/sec, specific gravity between 0.44-0.47g/mL, tap density between 0.62–0.68g/mL, compressibility between 13.00-13.33%, pH between 6.45–6, 48, dispersibility time between 02.14 – 02.17 minutes and water content between 3.48 – 4.93% according to SNI-01-2970-2006 instant milk powder. From the research results, it can be concluded that milk, egg yolk, and ginger can be formulated into instant powders to prevent stunting. All formula requirements meet the characteristics of instant powders.

ACKNOWLEDGMENT

The author would like to thank the Poltekkes Kemenkes Tasikmalaya, who funded this research from the DIPA Poltekkes Kemenkes Tasikmalaya, and to the Head of the Pharmacy Department of the Poltekkes Kemenkes Tasikmalaya for permitting the use of Temulawak plants obtained from the Pharmacy Department's TOGA garden.

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