Powder Milk Fortified with Whey Protein and Meniran Extract (*Phyllanthus niruri* L.) Encapsulated Casein Hydrolysate

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Abstract. Meniran plants were wild plants commonly used as herbal medicines, they contained several chemical compounds consisting of flavonoids, polyphenols, philanthine, etc. The use of meniran extract as immunomodulatory can protected from free radical attacks. Whey Protein Isolate (WPI) had role as foam maker and protein source. Casein hydrolysate had role as encapsulant. The interaction between proteins and phenolic compounds results in the modifications of the functional properties of proteins and phenolics. The interaction can result in foaming properties. The research objective determined the fortification of whey protein with meniran extract encapsulated casein hydrolysate on foam overrun, foam stability, particle size and optical microscopy of powdered milk. The method used an experimental method used a Completely Randomized Design. The data obtained were analyzed using analysis of variance and optical microscopy data analyzed descriptively. The addition of casein hydrolysate with different percentages showed no significant difference in foam overrun and particle size. However, there was a highly significant difference in foam stability and a significant difference in optical microscopy. The results in T2 with the addition of casein hydrolysate as much as 4 percent resulted in foam overrun 301.67, foam stability 300.83, particle size 1.73 and optical microscopy produced uniform bubble size. In conclusion, the fortification of whey protein with meniran extract encapsulated casein hydrolysate due to the interaction between polyphenols and protein increase foaming power and produce stable bubbles of powdered milk. It can produce meniran milk powder as a potential food, many health benefits and increase the body's resistance.

Keywords: Casein Hydrolysate · Foam · Meniran Extract · Powdered Milk · Whey Protein

1 Introduction

There are many things that can change people's habits during the covid-19 pandemic which significantly affect people's lifestyles, including changes in physical activity, sleep

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and diet [1]. A healthy diet is very important because it influences the gene expression levels of all cytokines, capable of modulating inflammatory processes and oxidative stress. This can be obtained from food, so it is necessary to have eating habits, lifestyle modifications and maintain proper nutritional status, especially during periods when there are many possibilities of being attacked by disease, it is necessary to increase the immune system to fight various diseases [2].

A new life behavior has been implemented to fight covid-19 with the obligation to adapt to pandemic conditions called New Normal Life. New Normal Life makes people pay more attention to be healthier by finding out that there is an increase in the consumption of vitamins and milk from the community. Healthy lifestyles are developed more strictly during the new normal, people are required not only to behave in a healthy manner but also to maintain body immunity. Maintaining this immunity can be done by implementing a good and healthy diet to maintain body fitness so that the body's immunity will increase [3]. One way to prevent diseases caused by the corona virus is to increase the immune system or body's resistance. Ways that can be done to increase the body's immunity are by adopting a healthy lifestyle by consuming lots of nutritious food [4].

Milk is one of the most important food ingredients for human health because it contains the necessary substances such as carbohydrates (lactose), protein, fat, vitamins and minerals [5]. Dairy cattle's milk has a high protein content so it is needed as a good source of nutrition for humans [6]. Milk has almost perfect nutritional value [5]. There is an influence during the Covid-19 pandemic on the habit of consumption milk in adults. There has been an increase in the frequency of consuming milk during the covid-19 pandemic, the consumers often consume milk from 23.2% before covid-19 pandemic to 31.5% during covid-19 pandemic. The consumers who rarely consume milk also lower during covid-19 pandemic from 60.2% to be 47.6%. Health benefits were identified as factors that positively affect milk consumption [7].

Fortification aims to increase nutrition and quality in food product so it can add some ingredients such as herbal plant in food product. It can become good combination to produce food product in dairy sector such as powdered milk when Covid-19 pandemic situation with the addition of herbal plant. Meniran is used as herbal ingredients, it contains several chemical compounds, including saponins, flavonoids, polyphenols, phyllanthine, hypophilantin and potassium salt. These compounds interact with each other so as to increase antioxidant activity. Clinically, meniran extract has been shown to be immunomodulatory or able to stimulate a person's immune system so that it is immune to attack [8].

Milk and meniran are the main ingredients that need to be considered for their shelf life when used in the long term. Milk is very sensitive to physical and microbiological influences and is susceptible to milk spoilage. This results in a low shelf life of milk. The development of food technology currently provides an alternative for milk processing as an effort to diversify dairy products in order to extend shelf life [5]. Spray drying is a drying process that converts a liquid product into a dry powder form, through the dispersion of droplets in a chamber that is in direct contact with hot air [9]. The advantages of spray drying are cost efficiency, extend shelf life, allow multiple production systems, continuous production and relatively shorter drying time compared to other drying methods [10]. The spray drying temperature used in the drying process includes high temperatures which can cause physical and chemical damage to materials that are not heat resistant, this will produce a hard textured powder and be more easily damaged.

Encapsulation is a technique to coat an active ingredient with a polymer wall layer to produce small micro or nano-sized particles. This coating can protect the active ingredient by adding a coating material used to coat the core material. The encapsulant used is derived from protein, such as casein hydrolysate. Casein hydrolysate is made from donkey or dairy cattle milk protein which consists of a mixture of 18 amino acids [11].

In milk, there are two main protein components consist of whey protein and casein. The casein content in milk protein is 80% and whey protein is 20%. The protein content of whey in milk is α-lactalbumin (α-La, 20%), β-lactoglobulin (β-Lg, 50%), bovine serum albumin (BSA, 10%), immunoglobulin (10%) and peptones proteases ($<$10%) [12]. Whey protein is widely used for food products because it has high nutritional and biological value (digestibility, amino acids, high biological value and good sensory characteristics) but also has the ability to form hydrogels at cold and hot temperatures [13]. Sodium caseinate (casein) has excellent surfactant properties, attributed to the amphiphilic nature of proteins used as emulsifiers, thickeners, and foaming agents in the food industry [14].

Foam is the dispersion of gas bubbles in a solid or liquid phase. Foam is thermodynamically unstable which means it will be in a separate phase at times. However, the foam breakdown kinetics can vary greatly in time whether it is a liquid foam or a solid foam [15]. Foam formation is influenced by adsorption of the foaming agent as an air-water interface and the ability of the foaming agent to rapidly reduce surface tension [16]. The relationship between β-lactoglobulins and polyphenols is very important because of their direct impact on emulsification properties [17]. Whey protein and phenolic compounds have interactions resulting in modifications in the functional properties of proteins and phenolics. This interaction can result in changes in whey protein solubility, thermal stability, digestibility, antioxidant activity, foaming and emulsifying properties [18]. One source of polyphenols is meniran (*Phyllanthus niruri* L.). The presence of a particle formation process incorporating polyphenols with protein will form a good emulsion. It can also produce a more stable foam [19]. Food products that have a foam texture are a favorite among many because of their light, light and smooth texture [15].

The use of two ingredients consists of whey protein and meniran extract did not affect in foam overrun and foam stability [20]. In this research will combine some ingredients for fortification so it can produce foam overrun and foam stability. The addition of casein hydrolysate can complement the use of the 3 main ingredients in the fortification of powdered milk consist of whey protein, meniran extract and encapsulant from casein hydrolysate.

The research objective is to determine the fortification of whey protein with meniran extract (*Phyllanthus niruri* L.) encapsulated casein hydrolysate with the use of different percentages on foam overrun, foam stability, particle size and optical microscopy of powdered milk so it will produce meniran powdered milk which will be tested based on foam overrun, foam stability, particle size and optical microscopy. It will produce meniran powdered milk who have many health benefits, especially it can increase endurance and is easily absorbed by the body.

2 Materials and Methods

2.1 Research Material and Method

Research Material

Fortification of whey protein with extract of meniran (*Phyllanthus niruri* L.) encapsulated casein hydrolysate in powdered milk. The ingredients were Whey Protein Isolate (WPI) 90 plain, meniran powder (*Phyllanthus niruri* L.), casein hydrolysate, aquadest, sodium azide and alcohol 70%. The equipment used in the research consisted of a Microwave Assisted Extraction (MAE) (SHARP R-222Y), evaporator, digital scales, hot plate (SH-2), magnetic stirrer, measuring cup, beaker glass, erlenmeyer, thermometer, stir bar, Whatman No. Filter paper. 4, glass funnel, petri dish, silicon mat, spatula spoon, plastic clip, label paper, tissue, aluminum foil, scissors, refrigerator and spray dryer (Buchi). The equipment used in the test consisted of a mini hand mixer, object glass, cover glass, dropper, plastic measuring cup, optical microscope (Olympus CX21FS1), nanowave II particle size analyzer (Microtract, USA).

Research Method

The research method used is an experimental method. Data analysis used experimental method with Completely Randomized Design (CRD) with a completely randomized design (CRD) with 5 treatments and 3 repetitions, the average data obtained was calculated, followed by analysis of variance (ANOVA). If there is a significant or highly significant difference, it will be continued with the DMRT (Duncan Multiple Range Test). The variables measured in this research are analysis of foam overrun, foam stability, particle size and optical microscopy. The tabulation data is presented below.

T0:	Powdered Milk
T1:	Powdered Milk + combination of whey protein-meniran extract encapsulated casein hydrolysate as much as 2%
T2:	Powdered Milk + combination of whey protein-meniran extract encapsulated casein hydrolysate as much as 4%
T3:	Powdered Milk + combination of whey protein-meniran extract encapsulated casein hydrolysate as much as 6%
T4:	Powdered Milk + combination of whey protein-meniran extract encapsulated casein hydrolysate as much as 8%

2.2 Research Procedures

Making Meniran Extract

Meniran powder was weighed as much as 3 g, dissolved with 100 ml of aquadest and homogenized. Then the maceration process was carried out by soaking the meniran powder with aquadest for 24 h. After that it was extracted with Microwave Assisted Extraction (MAE) for 10 min.

The meniran powder solution was put into a microwave oven at a temperature of 70 °C. Guarded and ensured every one minute and then turned off for 2 min (done until the 10th minute). It aims to maintain the temperature does not exceed 80 °C and prevent degradation of meniran bioactive compounds.

The results of the extraction of meniran have the characteristics of thick (crude extract) and brownish green in color. The extract was allowed to cool at room temperature, filtered using filter paper and stored in a refrigerator at 4 °C. The extract of liquid meniran was taken as much as 10 ml and then dried using an evaporator at a temperature of 50 °C (medium) for 6 min to reduce the water content of the meniran. The final result of meniran extract in the form of crumble form.

Preparation of Meniran Solution
Meniran extract was taken as much as 0.19 g, dissolved with 125 ml of aquadest and stirred until homogeneous.

Mixing with Whey Protein
Whey Protein Isolate (WPI) was prepared, weighed 30 g of WPI 90 and then dissolved with 564 ml of aquadest. Meniran extract was added as much as 36 ml until it became a combination of meniran extract and WPI 90 into a liquid sample.

Encapsulation by Spray Drying
The combination of WPI 90-meniran extract was then added with an encapsulant, namely casein hydrolysate as much as a percentage of each treatment (g). The sample was then homogenized using a magnetic stirrer. The sample used for the spraying process was 600 ml at a temperature of 162, 163 or 165 °C.

Fortification with Powdered Milk
The sample results after going through the spraying process are in powder form which will be fortified with powdered milk and homogenized using a magnetic stirrer. The total sample for each treatment was 2 g of sample which was then analyzed for foam overrun, foam stability, particle size and optical microscopy.

3 Results and Discussion

3.1 Foam Overrun

The results of the analysis of variance showed that the treatment with the addition of casein hydrolysate encapsulant with different percentages consist of 0%, 2%, 4%, 6% and 8% for fortified powdered milk with whey protein-meniran extract encapsulated casein hydrolysate gave no significantly different results ($P > 0.05$) to foam overrun which can be seen in Table 1.

Table 1. Foam overrun from fortification of powdered milk with whey protein-meniran extract encapsulated casein hydrolysate.

Treatment	Average ± SD
T0 (0%)	300.83 ± 1.44
T1 (2%)	300.83 ± 1.44
T2 (4%)	301.67 ± 1.44
T3 (6%)	301.67 ± 1.44
T4 (8%)	301.67 ± 1.44

Explanation: The use of casein hydrolysate encapsulation with different percentages for fortification of powdered milk with whey protein-meniran extract showed no significant difference in each treatment on foam overrun ($P > 0.05$).

Based on the results of the analysis of variance above, it can be seen that the addition of casein hydrolysate encapsulant with different percentages did not show a significant difference in each treatment of foam overrun ($P > 0.05$). The data on the ability to form foam at treatments T0, T1, T2, T3 and T4 resulted in an average value of 300.83 ± 1.44, 300.83 ± 1.44, 301.67 ± 1.44, 301.67 ± 1.44 and 301.67 ± 1.44. The foam overrun with the highest yield was found in the use of T2 (4%), T3 (6%) and T4 (8%) hydrolysate encapsulants with value is 301.67%. This was due to the ability of the protein derived from the casein hydrolysate to produce foam after stirring. Foaming overrun indicates the ability of the protein to form foam or foam after stirring. Stirring causes the protein molecules to break apart so this causes air bubbles to enter and stay inside and the volume will increase [21].

Casein proteins contain distinct hydrophobic and hydrophilic domains. Therefore, casein hydrolysate will be more likely to contain amphiphilic peptides, which may explain the superior foam-forming ability [22]. Amphiphiles are usually insoluble in water and thus form a monolayer at the water-air interface. Most of the hydrophobic films are made of insoluble molecules with the subface while the hydrophilic head group is useful for keeping the molecules in their interface environment and preventing the film from collapsing.

The lowest result is at T0 (0%) which is 300.83%. This is because the foaming overrun only comes from skimmed milk protein while the interaction of polyphenols in the meniran and protein when homogenized will form foam. The presence of foam indicates the formation of a film capable of trapping air that enters the solution through the mixture. The strength of the foam formed is influenced by the strength of the hydrophobic interaction between polyphenols and proteins [16]. T1 (2%) also had a low yield because it was suspected that the addition of casein hydrolysate as an addition to the protein source was small so that the ability to produce foam was not as much as the subsequent treatment which used more casein hydrolysate.

Table 2. Foam stability of fortification of powdered milk with whey protein-meniran extract encapsulated casein hydrolysate.

Treatment	Average ± SD
T0 (0%)	$251.67^{a} \pm 1.44$
T1 (2%)	$276.67^{cd} \pm 1.44$
T2 (4%)	$300.83^{d} \pm 1.44$
T3 (6%)	$275.85^{b} \pm 1.44$
T4 (8%)	$275.85^{bc} \pm 1.44$

Explanation: The use of casein hydrolysate encapsulants with different percentages for fortification of powdered milk with whey protein-meniran extract showed highly significant difference in each treatment on foam stability ($P < 0.01$).

3.2 Foam Stability

The results of the analysis of variance showed that the treatment with the addition of casein hydrolysate encapsulant with different percentages consist of 0%, 2%, 4%, 6% and 8% on fortified powdered milk with whey protein-meniran extract encapsulated casein hydrolysate gave highly significantly different results ($P < 0.01$) on foam stability which can be seen in Table 2.

Based on the results of the analysis of variance above, it can be seen that the addition of casein hydrolysate encapsulant with different percentages showed a highly significant difference in each treatment on foam stability ($P < 0.01$). The data on the ability to form foam at treatments T0, T1, T2, T3 and T4 resulted in an average value of 251.67 ± 1.44, 276.67 ± 1.44, 300.83 ± 1.44, 275.85 ± 1.44 and 275.85 ± 1.44. There was an increase in foam stability in the four treatments compared to T0 which only consisted of skimmed milk. Stability of foam formed from skimmed milk. There was 95% of the casein in micellar form which led to the presence of high amounts of casein micelles increasing the foam stability of skimmed milk [23]. The most stable skimmed milk foam is stabilized mostly by casein.

Foam stability with the highest yield was found in the use of T2 (4%) hydrolysate encapsulant, which was 300.83%. This is because of the interaction between proteins derived from whey and casein interacting with phenol compounds from meniran. The interaction between protein and phenolic components can occur due to hydrogen bonds between phenolic hydroxyl groups and NH- and CO- groups on proteins. The hydrophobic interaction between the non-polar part of the phenolic molecule and the non-polar part of the protein is capable of producing interactions between the phenolic component and the protein [24].

Protein-polyphenol interactions cause changes in function, secondary structure and nutritional properties of proteins [25]. Protein and phenolic compounds have been shown to interact, resulting in modifications in the functional properties of proteins and phenolics. This interaction can result in changes in protein solubility, thermal stability, digestibility, antioxidant activity, foaming and emulsifying properties [18]. Proteins are thought to interact with polyphenols through hydrophobic interactions [19].

The protein-phenol interaction is determined by the chemical structure of the phenol, such as the degree of polymerization, conformational flexibility and hydrophobicity. These chemical properties can lead to non-covalent and covalent interactions with proteins. Non-covalent interactions can occur through hydrogen bonds, van der Waals forces, electrostatic and hydrophobic interactions. Covalent interactions between phenols and proteins usually occur in the oxidation of phenols. The hydroxyl group on the phenol ring can be converted to quinone by enzymes or auto-oxidation. The protein-phenol interaction determines the interfacial and foam stabilizing properties [26].

A similar reaction was also found for sinapic acid, as the carboxyl and hydroxyl groups are ionized. Oxidized sinapic acid can form thomasidioic acid molecules and can be further converted to quinones. Quinones are electrophilic compounds that are stabilized by a conjugated cyclic ionic structure and are thus highly reactive to free thiols and amino groups in proteins. After the addition reaction, a covalent bond between the quinone and the protein is formed. The phenols in the protein-phenol complex can be oxidized a second time and thereby cross-link other proteins to eventually lead to the formation of protein-phenol aggregates. Changes in protein structure with phenol binding as a non-covalent interaction with phenol resulted in an increase in milk protein structure [26].

Protein-polyphenol particles are usually formed with individual proteins and polyphenols to stabilize polyphenol bioactivity. A blend of whey protein and polyphenols, formulated as a means to produce food grade functional particles to stabilize and improve food structure. The results of protein in the aggregate particles when added with polyphenols increased the total protein content and the use of small materials resulted in the polyphenol content being easily adsorbed onto the protein. The presence of a particle formation process incorporating polyphenols with whey protein will form a good emulsion. This resulted in a more stable foam and foam overrun was measured but did not show a significant difference. This is indicated by a longer half-life, or half time from the initial volume to flow from the foam [19].

The lowest result is at T0 (0%) which is 251.67%. This is because the source of the foam is only from skim milk protein. At T1 (2%) there is an increase in foam stability up to T2 (4%) then there is a decrease in foam stability at T3 (6%) and T4 (8%). This is because the sample has a high viscosity so that the spraying process becomes difficult and the results on the powder sample are easier to stick.

Encapsulated samples were more soluble in water than unencapsulated samples. This is due to the high concentration of hydrophobic amino acids in the casein hydrolysate used and the polarity of the material used as an encapsulating agent [27]. In addition, the more the addition of casein, the more surface area [28]. So that the more use of encapsulants results in easy stickiness and the more tightly it covers a particle causing the foam produced to be unstable and easy to break along with the wider surface area. The encapsulated material used in the spray drying process is wrinkle-forming. This causes the increasing use of encapsulants resulting in easy stickiness and the more tightly enveloping a particle (shrinkage) causing the foam produced to be unstable and easy to break accompanied by an increasing surface area [29].

The higher the addition of casein, the lower the total polyphenol content [28]. It is possible that the low value of total polyphenols is due to tannins which are one

Table 3. Particle size of fortified powdered milk with whey protein-meniran extract encapsulated casein hydrolysate.

Treatment	Average ± SD
T0 (0%)	2.05 ± 1.30
T1 (2%)	1.75 ± 0.39
T2 (4%)	1.73 ± 0.61
T3 (6%)	1.82 ± 0.62
T4 (8%)	2.30 ± 0.81

Explanation: The use of casein hydrolysate encapsulant with different percentages for fortification of powdered milk with whey protein-meniran extract showed no significant difference in each treatment on particle size ($P > 0.05$).

of the phenolic compounds that bind to proteins in casein. This leads to precipitation of polyphenols with casein. It can also be assumed that if tannins can be bound and precipitated with casein then it is possible that other polyphenols such as saponins will also precipitate. Saponins are triterpene glycosides which are surface active compounds and can cause foam when stirred with water [30].

3.3 Particle Size

The results of the analysis of variance showed that the treatment using casein hydrolysate encapsulated with different percentages consist of 0%, 2%, 4%, 6% and 8% fortified powdered milk with whey protein-meniran extract encapsulated casein hydrolysate did not give significantly different results ($P > 0.05$) to the particle size which can be seen in Table 3.

Based on the results of the analysis of variance above, it can be seen that the use of casein hydrolysate encapsulants with different percentages did not show any significant differences in each treatment on the particle size ($P > 0.05$). The particle size distribution ability data in the treatment T0, T1, T2, T3 and T4 resulted in an average value of 2.05 ± 1.30, 1.75 ± 0.39, 1.73 ± 0.61, 1.82 ± 0.62 and 2.30 ± 0.81. The particle size with the highest results were found in the use of T4 with hydrolysate casein as encapsulant (8%) which was 2.30%. This is because it has more protein content with the use of casein hydrolysate as much as 8%. The much larger difference in particle size can be attributed to higher molecular weight and stronger film-forming properties [27]. Large particle size indicates more total solids (protein) resulting in the formation of large aggregates [31].

Particle Size Analyzer (PSA) is an equipment that can be used to determine the size distribution of nanometer-sized particles. The lowest result is in T2 (4%) which is 1.73%. This is presumably because the particle distribution is not spread out much (between the foam close together) and the particle size is mostly uniform compared to other treatments, resulting in a low particle size value.

3.4 Optical Microscopy

Microscopic testing of the foam formed was carried out using an optical microscope with a magnification of 40× and 100×. The use of sample preparation as much as one drop on the object glass. This microscopic test of foam aims to determine the shape of the foam that is uniform or non-uniform and the distribution of the foam is evenly distributed on each side or spread. Optical microscopy image of protein foam (whey and casein)-polyphenol (meniran extract) formed is presented in Fig. 1.

The results of microscopic observations of foam from fortified powdered milk with whey protein-extract of meniran encapsulated by casein hydrolysate looked different in each treatment sample. The results of the distribution and shape of the foam can be seen in more detail at 100× magnification in Fig. 1.

At T0 (0%) only powdered milk was seen with uneven distribution, non-uniform foam and many voids between the foam. Based on increasing the degree of denaturation and protein aggregation before drying with a sprayer the resulting powder particles are larger, less dense, more porous, with a bubble-like microstructure and increased cohesiveness during powder flow than powders with higher protein levels [32]. Along with the addition of casein hydrolysate with different percentages, a significant difference was seen based on more even distribution, close distance between foams and more uniform foam shape. This can be seen using a 100× magnification microscope in Fig. 1.

In Figure (a2) belonging to T0 (only using skimmed milk) it produces bubbles that are not diverse, spread unevenly and are not close between bubbles. So, it needs to be modified in order to increase the functional properties of skimmed milk which can produce more foam and stable bubbles. This can be done by adding meniran extract and protein derived from protein and casein hydrolysate. The casein hydrolysate has two functions as an encapsulant that protects the particles during the manufacturing process from heat and other factors as well as an increase in protein source. The addition will result in hydrophobic interactions that reduce the surface tension and elasticity of the dilated surface of the film [17].

This can be seen in Figure (b2) belonging to T1 (2%) resulting in an increase in the shape of the particles that start to be uniform but their size is small and the distance between bubbles is getting closer. In Figure (c2) belonging to T2 (4%) has the best optical results with stable bubbles, uniform size, the distance between bubbles is not hollow, evenly spread because the surface is not wide and not easily broken. This is because the presence of polyphenolic compounds will stabilize the protein structure and decrease the elasticity of the film surface. So that when foaming, the foam produced will last longer and not break easily. Increasing the concentration of polyphenols from tea extract and carrageenan was able to change the protein structure and thicken the air bubble film layer which led to the stability of the protein structure [33].

However, in Figures (d2) belonging to T3 (6%) and (e2) belonging to T4 (8%) it can be seen that the particle size is not uniform, the distance is still close but the addition of >4% casein hydrolysate causes the foam stability to decrease so that it looks starting to there are cavities in Figures (d2) and (e2). It is suspected that there is an imbalance in the protein's ability to bind to phenolic compounds from meniran. As a result, the adsorption interface becomes lower and the layer on the air bubbles by optical microscopy analysis becomes thinner, breaks easily and there are cavities between the bubbles. The casein

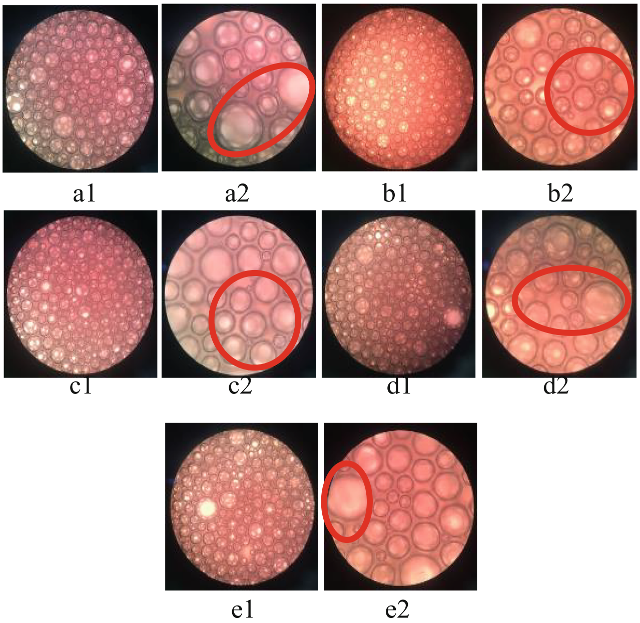

Fig. 1. Optical microscopy display of all samples each treatment
Explanation: The indicator 1 for magnification 40× and 2 for magnification 100×.

hydrolysate can indeed form a lot of foam, but the foam is not very stable if it is too much so that just one minute after stirring it is possible that the foam will run out [22]. The addition of a casein hydrolysate made a higher surface load detectable for the highly hydrophobic C-terminal peptide [15]. However, no correlation was found between the secondary structure at the interface and foaming. The effect of higher surface loads seems to be correlated with increased foaming.

The more use of casein hydrolysate can produce a larger foam size and more foam is produced after stirring, but with the addition of casein hydrolysate, the stability decreases. The encapsulated material used in the spray drying process is wrinkle-forming. This causes the increasing use of encapsulants resulting in easy stickiness and the more tightly enveloping a particle (shrinkage) causing the foam produced to be unstable and easy to break accompanied by an increasing surface area [29].

4 Conclusions

The results of the research that the fortification of whey protein with meniran extract (*Phyllanthus niruri* L.) encapsulated casein hydrolysate due to the interaction between polyphenols and protein increase foaming power (foam overrun) and produce stable bubbles (foam stability) of powdered milk. In conclusion, the fortification of whey protein with meniran extract (*Phyllanthus niruri* L.) encapsulated casein hydrolysate on powdered milk as much as 4% with the results can increase foam overrun, produce foam stability, lowest particle size and optical microscopy which produces uniform bubble size, stable bubbles, distribution does not spread, the distance between bubbles are close, the surface between bubbles is not hollow and the bubbles are not easy to collapse. The results obtained are milk powder fortified with whey protein and meniran extract encapsulated using casein hydrolyzate which can be processed into product who can developed on a laboratory, food and science scale. It will have many health benefits, especially it can increase endurance and is easily absorbed by the body.

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