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Viscosity and energy density tests on suction pudding formulations as an intervention for hypoalbuminemia

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ABSTRAK

Latar Belakang: *Hipoalbuminemia adalah kondisi rendahnya kadar albumin di dalam tubuh (serum< 3,5 g/dL) karena tubuh tidak cukup memproduksi protein albumin atau ketika tubuh kehilangan banyak albumin dalam tinja dan urin. Hipoalbuminemia dapat diintervensi dengan makanan tinggi protein. Putih telur, susu skim dan ikan gabus dapat diolah menjadi makanan selingan berupa pudding sebagai intervensi gizi untuk penderita hipoalbuminemia. Viskositas dan densitas energi menjadi parameter penilaian mutu fisik dan kimia pada produk yang dihasilkan.*

Tujuan: *Untuk mengetahui pengaruh penambahan ikan gabus, susu skim dan putih telur terhadap viskositas dan densitas energi pada puding sedot.*

Metode: *Penelitian eksperimen pembuatan puding sedot dengan empat formula. Perbandingan ikan gabus, putih telur dan susu skim yang berbeda, yaitu formulasi A (6.94%: 6.94%: 6.94%), formulasi B (10.41% : 0%: 10.41%), formulasi C (0%: 10.41%: 10.41%), dan formulasi D (10.41%: 10.41%:0%). Analisis viskositas enggunakan viskometer Brookfield NDJ-8S dan metode yang digunakan untuk pengujian analisis lemak adalah pendekatan gravimetri, metode Kjeldahl untuk penentuan protein, dan metode perbedaan untuk mengevaluasi kandungan karbohidrat. Nilai densitas energi puding sedot didapatkan dari hasil perbandingan antara kandungan energi dan berat pudding sedot. Nilai densitas energi puding sedot didapatkan dari hasil perbandingan antara kandungan energi dan berat pudding sedot. Data yang didapat dianalisis secara bivariat menggunakan uji one way ANOVA dengan uji lanjut DMRT.*

Hasil: *Formulasi A, B, C dan D dibedakan berdasarkan perbandingan kandungan ikan gabus, putih telur dan susu skim. Formulasi A (ikan gabus 6.94%: putih telur 6.94%: susu skim 6.94%), formulasi B (ikan gabus 10.41% : putih telur 0%: susu skim 10.41%), formulasi C (ikan gabus 0%: putih telur 10.41%: susu skim 10.41%), dan formulasi D (ikan gabus 10.41%: putih telur 10.41%: susu skim 0%). Hasil uji viskositas formulasi A, B, C dan D dalam kategori viskositas tinggi. Tidak ada perbedaan nyata nilai viskositas antara formulasi A, B, C dan D (p-value=0.346). Hasil densitas energi formulasi A, B, dan C dalam kategori densitas energi rendah sedangkan formulasi D sangat rendah. Ada perbedaan nyata densitas energi antara formulasi A, B, C dan D (p-value=0.000.*

Kesimpulan: *Perbedaan perbandingan putih telur, susu skim dan ikan gabus tidak memengaruhi viskositas pudding sedot, namun memiliki pengaruh terhadap densitas energi. Semakin besar kandungan energi pada bahan utama maka akan semakin besar densitas energi puding sedot.*

KATA KUNCI*: albumin; ikan gabus; pudding; putih telur; susu skim bubuk*

ABSTRACT

Background: *Hypoalbuminemia is a condition of low albumin levels in the body (serum <3.5 g/dL) because the body does not produce enough of albumin protein or when the body loses a lot of albumin in faeces and urine. Hypoalbuminemia can be treated with high protein foods. Egg whites, skim milk and snakehead can be processed into a snack such as pudding as a nutritional intervention for hypoalbuminemia. Viscosity and energy density are parameters used to assess food's physical and chemical quality.*

Objectives: *to determine the effect of adding snakehead fish, skim milk, and egg whites on the viscosity and energy density of sucked pudding.*

Methods: *This is experimental research using four formulas. The ratio of snakehead fish, egg whites, and skim milk is different. Formulation A (6.94%: 6.94%: 6.94%), formulation B (10.41%: 0%: 10.41%), formulation C (0%: 10.41%: 10.41%), and formulation D (10.41%: 10.41%:0%). The viscosity analysis used a Brookfield NDJ-8S viscometer and the methods used for fat analysis testing were the gravimetric approach, the Kjeldahl method for protein determination, and the difference method to evaluate carbohydrate content. The energy density value of sucked pudding was obtained from the comparison between energy content and weight of sucked pudding. The data obtained were analyzed bivariately using the one-way ANOVA followed by the DMRT for further testing*

Results: *Formulations A, B, C and D were differentiated based on the ratio of snakehead fish, egg whites and skim milk. Formulation A (snakehead fish 6.94% : egg white 6.94%: skim milk 6.94%), formulation B (snakehead fish 10.41%: egg white 0%: skim milk 10.41%), formulation C (snakehead fish 0%: egg white 10.41% : 10.41% skim milk), and formulation D (snakehead fish 10.41% : egg white 10.41% : skim milk 0%). The viscosity test results of formulations A, B, C and D are in the high viscosity category. There was no difference in viscosity values between formulations A, B, C, and D (p-value=0.346). The results of energy density of formulations A, B, and C are in the low energy density category while formulation D is very low. There is a significant difference in energy density between formulations A, B, C and D (p-value=0.000).*

Conclusions: *Egg white, skim milk and snakehead fish do not affect the viscosity test but affect the energy density. The greater the energy content of the main ingredients, the greater the energy density of the suction pudding.*

KEYWORD*: albumin; egg whites; pudding; skim milk; snakehead fish*

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INTRODUCTION

Serum albumin has historically been established as a marker of surgical risk, and some surgical guidelines recommend delaying surgery to allow time for improvement in serum albumin (1). Serum albumin is one of the molecules becoming the main protein in human plasma (3.4 – 4.7 g/dL) and makes up approximately 60% of total protein (2). Low albumin levels indicate functional disorders that can lead to mortality. A decrease in albumin can be used as an indication of protein deficiency and a sign of inflammation in the body, which can result in malnutrition (3). The increase or decrease in albumin levels is influenced by protein intake, alcohol, osmotic pressure, hormones, and physiological factors. The condition of serum albumin levels <3.5 g/dL is stated as hypoalbuminemia, (4).

Malnutrition data from hospitals of Indonesia shows that 40-50% of patients experience hypoalbuminemia or are at risk of hypoalbuminemia, 12% of whom have severe hypoalbuminemia. The hospital stay of patients with malnutrition is 90% longer than that of patients with good nutrition (5). Apart from malnutrition, hypoalbuminemia generally occurs in patients with kidney disorders, chronic liver disorders, burns and cancer/malignancies, pregnancy, congestive heart failure, and malabsorption syndrome. Hypoalbuminemia reflects insufficient absorption of amino acids from

protein, thereby disrupting the synthesis of albumin and other proteins in the liver. Decreased albumin synthesis is a result of less effective nutritional intake and reduced albumin gene transcription (6). Other factors including decreased synthesis, increased catabolism, and increased gastrointestinal excretion can also cause hypoalbuminemia (7).

In general, the albumin levels of patients treated in hospitals can be increased by administering intravenous albumin fluids and providing protein-rich foods. Intravenous administration of albumin is rarely done because it is expensive and is usually given if the albumin level is below 2.0 g/dL, whereas in conditions where the albumin is below 3.5 g/dL but still above 2.5 g/dL, an intervention in the form of giving egg whites has been an effective method used to increase serum albumin. This is due to the economic value of eggs and the 95% content of egg whites in the form of albumin, which is divided into the form of ovalbumin, ovomucoid, lysozyme, ovomucoin, avidin, and ovoglobulin (8). The half-life of albumin in plasma ranges from 8-20 days, so it takes at least 7-10 days to reach normal plasma albumin levels again (9).

The nutritional content of 100 grams of egg whites is 10.5 grams of protein, with 10 grams of albumin, and as a therapy to increase albumin, you need to give egg whites three times for 14 days (8). However, continuous consumption of egg whites can cause boredom and decreased intake for patients. Therefore, it is necessary to develop products with similar nutritional value for hypoalbuminemia patients. In addition to egg whites, snakehead fish is also known to be therapeutic in increasing albumin levels, and there is no difference in increasing albumin levels with both egg whites and snakehead extract (10). Pudding is known to be a low-calorie food, making it suitable to be made as an alternative modification of nutritional therapy food, but the modification of pudding as a therapy food should require special attention to its nutritional content.

Pudding is a popular food for people of all ages. The pudding, which has a soft, sweet texture, can be created as a complementary food to increase weight and nutritional status in toddlers, (11). Therefore, there is an opportunity to develop a type of pudding created with a formulation of high-protein ingredients that still have a soft texture but are high in protein, which is expected to be a nutritional intervention for hypoalbuminemia patients (12).

MATERIALS AND METHODS

This research used a Completely Randomized Design (CRD). The parameters tested were viscosity and energy density. There were 4 formulations made with the ratio of snakehead fish, egg whites, and skim milk is different. Formulation A (6.94%: 6.94%: 6.94%), formulation B (10.41%: 0: 10.41%), formulation C (0: 10.41%: 10.41%), and formulation D (10.41%: 10.41%:0):

Table 1. Percentage of sucked pudding raw materials (12)

Materials	Formulation A	Formulation B	Formulation C	Formulation D
Water	69.4%	69.44%	69.44%	69.44%
Sugar	6.94%	6.94%	6.94%	6.94%
Snakehead fish	6.94%	10.41%	0	10.41%
Egg whites	6.94%	0	10.41%	10.41%
Skim milk	6.94%	10.41%	10.41%	0
Maizena	2.8%	2.8%	2.8%	2.8%
Ginger extract	5%	5%	5%	5%
Carrageenan	0.5%	0.5%	0.5%	0.5%

Viscosity and energy density test was conducted at the Chemical, Processing, and Sensory Laboratory of Agricultural Products, Faculty of Agriculture, Sriwijaya University. The instrument utilized to measure the viscosity of the sucked pudding is Brookfield NDJ-8S viscometer and to determine the energy content, the fat, protein and carbohydrate must be tested. The methods used for testing include the gravimetric approach for fat analysis, the Kjeldahl method for

protein determination and the difference method for evaluating carbohydrate content (13,14). The energy density value of sucked pudding is obtained from the comparison between energy content and total weight of Sucked Pudding.

RESULTS AND DISCUSSIONS

The results of the viscosity and energy density tests on all sucked pudding formulations are presented in **Table 2**. The ANOVA test showed that there was no significant difference in the viscosity test results for all pudding samples. Besides, the test also showed that there was a significant difference in the calculation of energy density for all sucked pudding samples with a p-value <0.005 (0.000). To determine which groups were significant, the Duncan test was carried out. The results of the Duncan test showed that each sample: A and B, A and C, A and D, B and C, B and D, and samples C and D, was significantly different. The viscosity value of sucked pudding was influenced by the various ingredients in it, if the higher of protein content in the ingredient, the higher the viscosity value of the product (15). The protein content in the three main ingredients, every 100 g is 30 g for powdered skim milk, 16.2 g for snakehead fish, and 10.8 g for egg whites.

Research carried out that the addition of extract snakehead fish could increase the viscosity of skin lotion because the albumin protein in snakehead fish could form a three-dimensional network due to the bonds between proteins. Water, which acted as an emulsifier, was trapped inside and outside the albumin so that it could increase the viscosity value of a product (16). Apart from that, fish containing myofibrillar protein or water-soluble protein was the most common component found in fish tissue. Myofibril proteins played a role in muscle contraction, gel formation, and binding water (17). Gel formation and coagulation occurred due to the role of myofibril proteins, especially actomyosin. This myofibril protein could create a gel in fish flesh. Gel formation in fish became weak when it was exposed to acid. The higher the acid in a product, the lower the viscosity value would be (18,19). Therefore, when washing fish, a little lime was slightly added to remove the fishy smell of the fish. Viscosity can also be affected by molecular weight. Snakehead fish has a dense texture, so when it is dissolved in water, it can form a liquid with many soluble particles per unit volume. This makes a product containing snakehead fish have a higher viscosity, (20).

Table 2. Sucked Pudding Viscosity Test

Variable	Formulation of Suction Pudding				p-value
	A Mean±SD	B Mean±SD	C Mean±SD	D Mean±SD	
Scores Viscosity (mPa·s)	1.128.500 ± 340.118[a]	1.265.000 ± 728.319[a]	1.177.000 ± 380.423[a]	361.199.5 ± 385.796[a]	0.346
Density Energy (kcal/g)	0.64 ± 0.000[a]	0.88 ± 0.007[b]	0.83 ± 0.014[c]	0.50 ± 0.007[d]	0.000

Note: different letter notations in the same row indicating that there was a significant difference in the Duncan test results with a value of α=0.05. Formula A, B C, and D are formulation of suction pudding.

Egg whites also have a high protein content, and around 95% of the total protein is albumin (21). However, adding egg whites to a product does not have any significance because the water content in egg whites is 88% of the total (22). This causes egg whites not to significantly affect the viscosity of a product. The characteristic of powdered skim milk is having a low water content, namely 3.5%, while snakehead fish have a water content of 79%, and egg whites have 87.8%, so the addition of skim milk can absorb more water. Apart from that, milk is also high in protein. As much as 80% of the total milk protein is casein, which is usually used as an emulsifier for various products (such as cheese, ice cream, and butter). Casein in milk is also amphiphilic (like water and fat) which can facilitate absorption into oil or water. Besides, casein can produce unstable bioactive components (23). This property causes milk to have the ability to bind small molecules, emulsify, and can also bind water well (24). Therefore, milk can stabilize the emulsion and form a good gel, so the greater the addition of powdered skim milk, the higher the density level of a product. It means it

can produce a product that has a high viscosity (25). This result is in line with research stating that the addition of powdered ingredients to coconut syrup increased the viscosity value of the syrup (26).

Based on the properties of the various main ingredients in the sucked pudding formulations, it was found that all sucked pudding formulations were in the high-viscosity food category. The different viscosity values in each formulation were influenced by the different ratio of snakehead fish, egg whites, and skim milk. In this study, the pudding produced was not only made from milk, so the viscosity of sucked pudding had a higher viscosity than pudding in general. Formulation A had the main ingredients of snakehead fish at 6.94%, chicken egg whites at 6.94%, and skim milk at 6.94%. Formulation B contained the main ingredients of snakehead fish at 10.41%, and skim milk at 10.41%.

In formulation C, which had 10.41% chicken egg whites as its main ingredient and 10.41% skim milk, the viscosity value of formulation C was not as thick as in formulation B. This was influenced by the nature of egg whites, which had a higher water content and was a low emulsifier. These three ingredients were high in protein, but the same egg whites and powdered skim milk content made formulation A have a lower viscosity compared to formulations that had a higher powdered skim milk content (formulations B and C). In formulation D, based on table 2, it could be seen that there was a difference in viscosity value in sample D which had the lowest viscosity value compared to other sucked pudding formulations. Formula D, with the main ingredients of snakehead fish at 10.41% and chicken egg whites at 10.41%, did not contain skim milk. This caused formulation D to have more water, causing formulation D to have a lower viscosity value than other formulations. The properties of snakehead fish and powdered skim milk, which had high protein content and could increase the molecular mass to become denser, caused formulation B to have a high viscosity value compared to all existing formulations.

The discussion above was in line with research that stated the use of skimmed milk powder in goat milk curd increased the viscosity value of the curd product (27). It can be concluded that the greater the addition of skim milk to a product, the higher the level of density of a product, resulting in a product with a high viscosity, (28). This caused samples A, B, and C to have higher viscosity values compared to the viscosity values in sample D.

From the results of the viscosity tests on various sucked pudding formulations, it was found that when the primary component in the formulation of the suction pudding was a protein as rich ingredient, the outcomes were consistent, as confirmed by statistical analysis indicating no significant differences among the formulations. This means that if a modified food ingredient is made using high protein ingredients, it can produce a product with high physical characteristics (viscosity). This lack of difference was due to the protein content of the main ingredients, such as snakehead fish, which provides 16.2 grams of protein, egg whites contain 10.8 grams of protein, and powdered skim milk offers 30 grams of protein in every 100g of ingredients. These three products were products with high protein content (10,22,27). The results of the viscosity test in this study were that all sucked pudding formulations belonged to the high-viscosity food category. Food with high viscosity had a thick texture, which means the formulated suction pudding has met the requirements for the characteristics of sucked pudding which had the physical characteristics of being soft, not too dense like ordinary pudding but not liquid like water (29).

Energy density is the energy content in food that has been divided by the total weight of a food (30). In this study, the total weight used was 100 g. Calculating the energy density of food aims to determine the quality of the nutritional content of the food (31). The statistical analysis showed that there was a significant difference in the energy density of all sucked pudding samples. In general, this difference was caused by the main ingredients substituted in each suction pudding formulation. The difference of energy content in formulation A, B, C and D can be influenced by the main ingredients of sucked pudding. The samples in this study had four formulations with substitution of the main ingredients: snakehead fish, egg whites, and skim milk with formulations A (6.94%: 6.94%: 6.94%), B (10.41%: 0: 10, 41%), C (0:

10.41%: 10.41%), and D (10.41%: 10.41%: 0). The difference in the type of main ingredient caused the total weight and energy content of the sucked pudding to be different and affected the energy density of sucked pudding. The energy content of 100 g of snakehead fish is 80 kcal, egg whites have 50 kcal, and skim milk has 366.6 kcal (32). This energy content that makes every formulation of suction pudding has a difference of energy content, which formula A has 64,7 kcal, formula B has 89,23 kcal, formula C has 83,55 kcal and formula D has 51,02 kcal (12). When water is added in the formulation, the suction pudding formulations experienced differences in weight for each formulation. Formulation A had a total weight of 975 g, formulation B had a total weight of 1,220 g, formulation C had a total weight of 984 g, and formulation D had a total weight of 1,162 g. The difference in energy content and dissolved mass caused the density of each formulation to be different.

The difference in energy density was caused by the presence of different concentrations of the main ingredients of snakehead fish, egg whites, and skim milk, which produced different energy content and total weight. Sample A (6.94%: 6.94%: 6.94%) had an energy density of 0.64 kcal/g with the same material composition, so it belonged to a moderate energy density value compared to the other samples. Sample B (10.41% : 0: 10.41%) had an energy density of 0.88 kcal/g. Sample B had the highest energy density compared to the other samples. This was due to the combination of the addition of snakehead fish at 10, 41% and skim milk at 10.41% where the energy content of snakehead fish had a greater energy content than the energy value of egg whites. Sample C (0: 10.41%: 10.41%) had an energy density of 0.83 kcal/g. This sample was a substitute for egg whites 10.41% and skim milk 10.41%. Skim milk contributed greatly to the additional energy, but egg whites had a lower energy content compared to snakehead fish, so formulation C had a slightly lower energy density compared to sample B, and sample D (10.41%: 10.41%:0) had the lowest energy density, namely equal to 0.50 kcal/g. This was because the energy content in snakehead fish and egg whites was still lower than the energy in powdered skim milk.

From the results of energy density calculations in each pudding formulation, the energy density contained in sample A had a value of 0.64 kcal/g, sample B had a value of 0.88 kcal/g, and sample C had a value of 0.83 kcal/g. It means they belonged to a medium-density food, while sample D had a low density, namely 0.50 kcal/g. The results of statistical analysis showing differences between sucked pudding formulations indicated that there was an influence between ingredients that caused differences in energy density. This means that if a modified food product is made using high-energy ingredients, it can produce a product with a high energy density. Apart from that, the greater the total weight of a product compared to its energy content, the lower the energy density produced.

It is necessary to know the energy density of a food to determine the quality of the nutritional content. A product must not have a density that is too low or too high to be classified as food with good nutritional quality. When compared with the energy density requirements for additional food for adult malnutrition that have been set by the WHO (World Health Organization) and the Directorate of Processed Food Standardization requirements for Food for Special Medical Needs (PKMK), namely at the limit of 0.8 kcal/g to 2 kcal/g, the sample puddings B and C meet the requirements to be used as additional food for patients with hypoalbuminemia, while formulations A and D still have low energy density, so they cannot be used as nutritional therapy food for hypoalbuminemia patients.

CONCLUSIONS AND RECOMMENDATIONS

There was no significant difference in viscosity values between formulations A, B, C, and D. However, the combination with skim milk caused the product to be thicker than formulations without skim milk. All formulations met the standard physical characteristics of pudding as they included high viscosity. In addition, there was a significant difference in energy density between formulations A, B, C, and D. Formulations B and C have an energy density of 0.88 kcal/g and 0.83 kcal/g, so that formulations that meet the standards and can be recommended for hypoalbuminemia patients.

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