Carbohydrate, Protein, and Protein Digestibility Contents of Silky Pudding with Goat's Milk and Green Bean Flour Substitution

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Abstract. Background: Goat's milk and mung beans are suitable food ingredients for enhancing the diet of stunting toddlers due to their significant nutritious content, particularly in terms of protein and carbs. Objective: The objective of this study is to assess the protein, carbohydrate, and protein digestibility levels of Silky Pudding produced through the substitution of goat's milk and mung bean flour. Methods: The present study employs a genuine experiment methodology, specifically utilizing a completely randomized design (CRD). The experiment involved utilizing a formula that substituted cow's milk and goat's milk in the following ratios: P0 (100:0), P1 (75:25), P2 (50:50), and P3 (25:75). Additionally, mung bean flour was added to each formulation, with a weight of P0 (0g), P1 (3g), P2 (5g), and P3 (7g). The experiment was repeated six times. Subsequently, the Kjeldal method was employed to assess the protein content, the by difference approach was utilized to determine the carbohydrate content, and the in vitro method was employed to evaluate protein digestibility. The normality of the data was assessed using the Shapiro-Wilk test, followed by examination using the Independent T-Test and LSD Follow-up Test. Results: The findings of the research revealed that the protein content varied between 3.9% and 5.7%, the carbs varied between 85.7% and 88.8%, and the protein digestibility varied between 11.7% and 14.6%. The analysis results indicated a rise in protein content, but the carbohydrate content and protein digestibility exhibited a reduction. The incorporation of goat's milk and mung bean flour into silky pudding yields notable results in terms of protein content, carbohydrate composition, and protein digestibility.

Keywords: Goat’s Milk, Mung Beans, Silky Pudding, Stunting

1. Introduction

Stunting is currently the priority health problem. Stunting is a condition where the growth of children under five is stunted due to a chronic lack of nutrition which makes the child

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too short for his age [7]. According to the data from the last three years of monitoring Nutritional Status (MNS), stunting is more prevalent than other problems like wasting, undernutrition, and obesity. A way to overcome this problem is providing supplementary feeding recovery, or what is commonly referred to as PMT-P to toddlers [10].

The PMT content that will be given to stunted children is essential and needs to be taken into account that is the protein level and the protein digestibility. The PMT content that will be given to stunted children is essential and needs to be considered, including protein level and protein digestibility. The protein in PMT is reviewed from several aspects including protein content and protein quality [12]. Another needed macronutrient is carbohydrates, which function to produce energy; during toddlerhood, when the level of play activity is high, energy is needed for brain development [14].

It is crucial to select meals that can meet the nutritional requirements of toddlers in order to promote their growth and development. Typically, the body requires six fundamental nutrients: energy, protein, fat, carbs, vitamins, and minerals like iron (Fe) and zinc (Zn) [1]. One of those nutrients can be contained in mung bean and goat's milk. Fresh goat's milk contains 4,3g of protein and 6,6g of carbohydrates per 100g. Mung bean contains 22,2 g of protein and 62,9 g of carbohydrates per 100 gr [3]. Goat's milk has an excelllent prospective development. It contains nutritional composition and unique characteristics if compared to cow's milk because it contains more fat, protein, mineral vitamin A, and vitamin B than cow's milk [20]. Goat's milk has small globules (fat granules) to ease the digestive process in the body [26]. Mung beans are a notable vegetable protein source that contributes to the enhancement of nutritional status. According to Nisa [13], the nutritional composition of 100 grams of the substance includes 323 kcal, 22.9 g of protein, 1.5 g of fat, and 568 g of carbohydrates. In comparison, mung bean flour is found to include 19.09% protein, 0.09% fat, 2.76% coarse fiber, and 72.86% carbohydrates.

Build upon research by [17] shows that the substitution of goat's milk and skimmed milk both have effects on increase the protein level of silky pudding. An observation that was made in the Integrated Service Post (Posyandu) Mawar Brebes showed that >50% of children preferred supplementary feeding (PMT) in the form of a silky pudding to biscuits form.

Based on this, researchers want to determine the effect of the substituting goat's milk and mung bean flour in making silky pudding on carbohydrates, protein, and protein digestibility so that it can be used as a suitable supplementary food (MT).

2. Methods

This research is a True Experimental using Completely Randomized Design (CRD) which has four treatments with the ratio of cow's milk and goat's milk which is P0 (100:0), P1

(75:25), P2 (50:50), P3 (25:75), and the addition of mung bean flour each formulation P0 (0g), P1 (3g), P2 (5g) and P3 (7g) with six times repetitions. This research was conducted at the Food Processing Laboratory (production silky pudding), Food Chemistry Laboratory (Carbohydrate and Protein Content Testing) Faculty of Nursing and Health Science, University of Muhammadiyah Semarang and Yogyakarta Chem-Mix Laboratory (Protein Digestibility Test) from November 2022 to February 2023. In this research, the equipment used included scales, spoons, basins, 80 mesh sieves, cabin dryers, grinder machines, stoves, pans, measuring cups, whisks, trays, Kjeldhal flasks, distillation flasks, Erlenmeyer flasks, baths, burettes, pipettes, volume, measuring pipette, measuring cup, shaker, millipore filter, and a small glass. The ingredients used in this research include mung beans without skin, water, plain fresh milk, Etawa goat's milk, mung bean flour, plain gelatin, plain jelly, granulated sugar, palm sugar, cornstarch, boric acid (H3BO3) saturated 4%, NaOH 40%, concentrated H2SO4, selenium, MR indicator, HCl 0.1 N, Na-Borax 0.1 N, MO indicator, NaOH 0.5 N, Na-phosphate buffer 0.2 M pH 8, distilled water. A silky pudding formulation is shown in Table 1.

Table 1. Silky Pudding Formulation

Ingredients	P0	P1	P2	P3
Plain fresh milk (%)	100	75	50	25
Goat's milk (%)	-	25	50	75
Mung bean flour (g)	-	3	5	7
Jelly (g)	2	2	2	2
Plain jelly (g)	2	2	2	2
Sugar (g)	40	40	40	40
Palm sugar (g)	40	40	40	40
Cornstarch (g)	6	6	6	6

2.1. Mung Bean Flour Production

At first, the mung beans are sorted from the mung beans that are not good and are attacked by pests; then the mung beans are soaked in water for 12 hours. After that, steam the mung beans for 20 minutes, then drain. Mung beans that have been steamed and drained are then dried using a cabinet dryer for 24 hours at a temperature of 50° C. After drying, the mung beans are ground using a grinder machine and then sieved using an 80-mesh sieve.

2.2. Silky Pudding Production

The production process starts with mixing ¾ goat's milk, fresh milk, palm sugar, sugar, jelly plain, jelly, and mung bean flour (based on formulation) in a pan until it's homogeny, then heat at 70° C temperature for 10 minutes. Mix the cornstarch with the remaining ¼ of the

goat's milk then mix it into the pan and stir continuously for 2 minutes. After that, let it sit until it's no longer smoking, then mold it in a plastic cup with a diameter of 6.5 cm.

2.3. Analysis of Protein Level [6]

This Analysis method uses a Kjeldhal method which has three stages. The first stage is destruction; it starts with scaling 0,5 g of the sample then put into kjeldhal flask and add concentrated H2SO4 and a little selenium, then heating the sample until the solution is clear. The second stage is distillation; it starts with the solution obtained, is then cooled and diluted with distilled water, and then transferred into a distillation flask. Rinse the kjeldhal flask with distilled water until ¾ of the part then put it in the distillation flask, then add 10 ml of NaOH and 3 drops of PP indicator. Put 5 ml of H3BO3 in an Erlenmeyer flask and MR indicator. Install the distillation apparatus, attach the pipe as a connector until it is immersed in boric acid, and distill until the volume is 25ml and the color becomes yellow. The third stage is titration. Carry out titration using standardized HCl until the color changes from yellow to red, record the resulting volume then calculate it as nitrogen level using the following formula:

$$\%\mathrm{N} = \frac{\text{v HCl x N HCl x 14,007 x 100}}{\text{m gram sample}}$$

Convert %N into protein level using the following formula:

%protein level = %N x conversion factor (6,25)

Analysis of Protein Digestibility [22]

Protein digestibility analysis uses the in vitro method. First, weigh 5 g of the sample, put it in an Erlenmeyer flask, then add 20 ml of Whaffole buffer, add 2 ml of pepsin enzyme then incubate at 40°C for one hour. Filter the solution, add 5 ml of TCA, and let it sit for one hour, then take 5 ml of the filtrate for analysis. Calculate it using the following formula:

$$\text{protein digestibility} = \frac{\%\text{protein enzyme level}}{\%\text{total protein level}}\ x\ 100$$

2.4. Analysis of Carbohydrates Level [21]

Carbohydrate level analysis uses by difference method in which carbohydrate levels are obtained by reducing 100% with protein level, water, ash, and fats.

2.5. Data Analysis

The data of protein level, protein digestibility, and carbohydrate was tested for normality using Shapiro Wilk and then analyzed statistically using the independent T-test and if there was an influence, the LSD (Least Significance Different) test was used to continue. The data were presented as a mean rank with a significant p-value of 0,05.

3. Results and Discussion

3.1. Protein level

The result of Silky Pudding protein level analysis is shown in Figure 1.

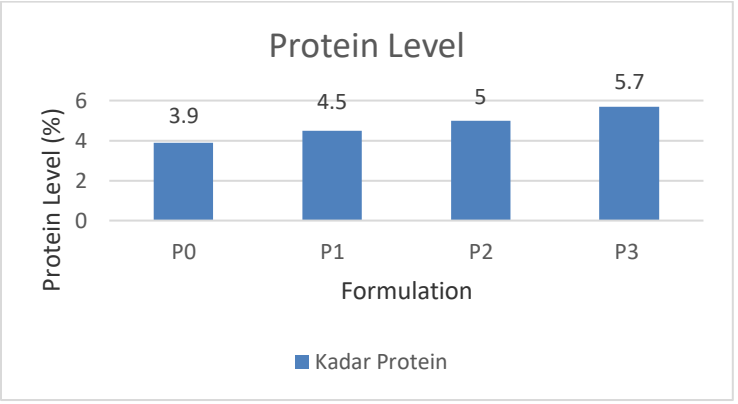

Fig. 1. Development of protein levels based on goat's milk and mung bean flour substitution in silky pudding.

According to Figure 1. Shows that protein levels in silky pudding was found ranges from 3,9-5,7%. The lowest protein level is in P0 (100:0) at only 3,9% while the highest protein level is in P3 (25:75) at 5,7% (7g). Goat's milk and mung bean are the source of protein. Protein content in goat's milk consists of 3,1% casein and 0,4% lactalbumin, it is also rich in amino acid in some forms like arginine, phenylalanine, histidine, and amino acid non-essential like glutamine acid, hydroxyglutamine acid, and so on [11]. Mung bean is one of the legumes that is rich in isoflavone protein, and contains lots of the amino acids leucine, arginine, isoleucine, valine, and lysine [4]. The increase in protein content in silky pudding is related to the high protein content contained in goat's milk, that is 4.3 g / 100 g [3] and mung bean flour contains around 19,09% / 100 g [13]. Protein content is one of the requirements for supplementary feeding-recovery (PMT-P) in every 100g must be 8-12 g [9]. In order to fulfill the quality requirement of supplementary feeding-recovery, toddlers

must consume 2-3 cups of silky pudding weighing 60 g. The effect of various goat's milk and mung bean flour substitutions which every treatment in increasing protein levels after analyzed is shown in Table 2.

Table 2. The effect of goat's milk and mung bean flour substitution on protein levels in Silky Pudding.

Treatment	B	*P*	95% Confidence Interval		Partial Eta Squared
			Lower Bound	Upper Bound	
P3	1,68	0,001	0,82	2,54	45%
P2	1,11	0,014	0,25	1,97	27%
P1	0,58	0,177	-0,28	1,44	9%
P0	Group Refference				

Table 2. shows that the addition of goat's milk and mung bean flour will have a significant effect on increasing protein levels. The P3 (25:75) (7g) formulation could increase the highest protein level up to 45% by difference with P0 (100:0) (0g) is 1,68 and that is a very significant increase (p=0,001). Get to know to determine the differences in treatment of the three formulations, further tests were carried out using the Least Significance Difference (LSD), as shown in Table 3.

Table 3. The difference in protein levels between goat's milk substitution and mung bean flour in silky pudding.

Treatment		Mean Different	Std. Error	*p*	95% Confidence Interval	
					Lower Bound	Upper Bound
P3	P2	0,58	0,41	0,178	-0,28	1,44
	P1	1,11	0,41	0,014	0,25	1,97
P2	P1	0,53	0,41	0,213	-0,33	1,39

Table 3. shows that silky pudding with P3 (25:75) (7g) treatment is higher in increasing protein levels significantly compared to P1 (75:25) (3g) treatment (p=0,014). According to the LSD test, it shows that silky pudding with P3 (25:75) (7g) treatment is the best formulation in increasing protein levels.

Protein is a group of macronutrients, unlike other macronutrients (carbohydrates, fat) this protein can also be used as an energy source. Protein is a source of energy that the body needs. Protein is a very important nutrient for the body because it acts as a builder and regulator, and also acts as fuel in the body. Protein is a source of amino acids containing the elements C, H, O, and N which are not found in fat and carbohydrates.

According to research conducted by Sunarlim and Setiyanto [24], it shows that the protein content of goat's milk yogurt is higher than cow's milk yogurt. The addition of mung bean flour, the higher the protein content in the silky pudding. This is in line with research conducted by Wardani [25] that the more mung bean flour is added, the higher the protein content in sponge cake, this is due to the high content of protein contained in mung beans is 19.09% / 100 g [16].

3.2. Carbohydrate Levels

The calculation of carbohydrate content is produced by subtracting other nutrients such as water content, ash, fat, and protein content. The results of the subtracting analysis are as follows.

Water Content

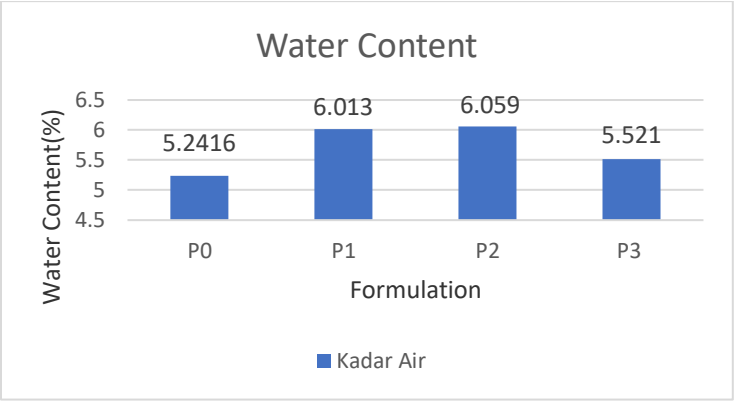

Fig. 2. Water content in Silky Pudding.

According to Figure 2. It shows that water content in silky pudding ranges from 5,2416 to 6,059%. The lowest water content was found in P0 (100:0) (0g) treatment at 5,2416% while the highest water content is in P2 (50:50) (5g) at 6,059%.

Ash content

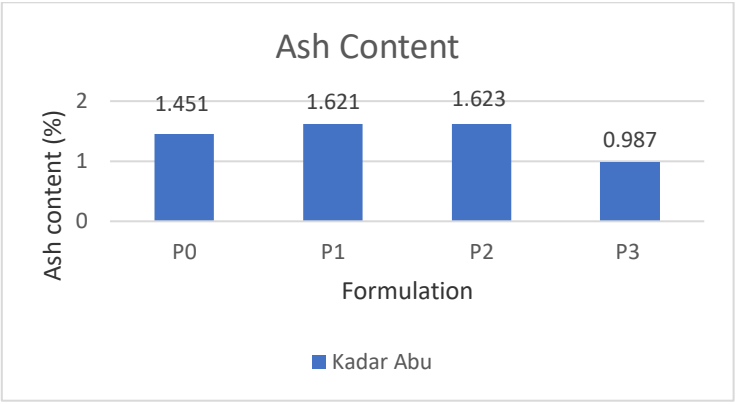

Fig. 3. Ash content in Silky Pudding.

According to Figure 3. It shows that ash content in silky pudding ranges from 0,987 to 1,623%. The lowest ash content was found in P3 (25:75) (7g) treatment at 0,987% while the highest content is in P2 (50:50) (5g) treatment at 1,623%.

Fat Level

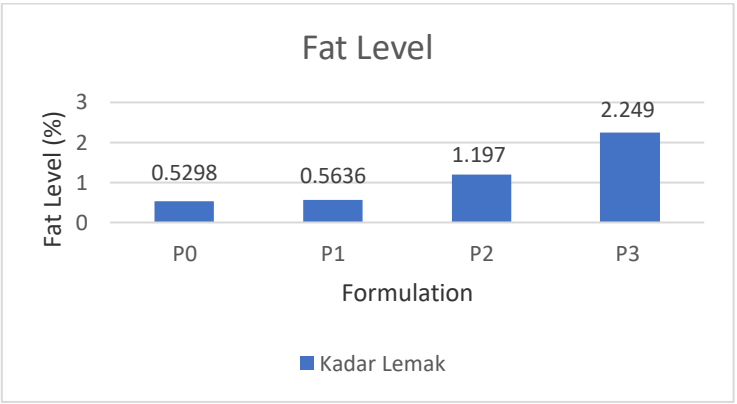

Fig. 4. Fat Level in Silky Pudding.

According to Figure 4. It shows that the fat level in silky pudding ranges from 0,5298 to 2,249%. The lowest fat level was found in P0 (100:0) (0g) treatment at 0,5298% while the highest level is P3 (75:25) (7g) treatment at 2,249%.

Analysis Result of Carbohydrate Levels

Fig. 5. shows the result of silky pudding carbohydrate levels.

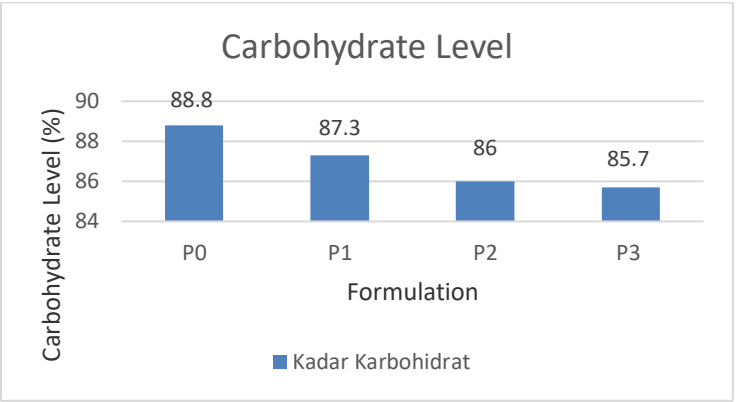

Fig. 5. Development of carbohydrate levels according to goat's milk substitution and mung bean flour in silky pudding.

Based on Figure 5. it shows that the carbohydrate content in silky pudding ranges from 85.7-88.8%. The lowest carbohydrate content was found in P3 (25:75) (7g) at 85.7% and the highest was at P0 (100:0) (0g) at 88.8%. The decrease in carbohydrate levels in silky pudding is related to the main carbohydrate content in the ingredients such as milk. In this case, lactose is the main carbohydrate. The lactose in goat's milk is 0.2-0.5% lower than in cow's milk [19] so as the proportion of goat's milk increases, the carbohydrate content decreases. The effect of various substitutions for goat's milk and mung bean flour for each treatment on reducing carbohydrate levels is shown in Table 4.

Table 4. The effect of substitution of goat's milk and mung bean flour on Carbohydrate levels in silky pudding.

Treatment	B	*p*	95% Confidence Interval		Partial Eta Squared
			Lower Bound	Upper Bound	
P3	-3,22	0,001	-4,92	-1,52	44%
P2	-2,76	0,003	-4,47	-1,06	36%
P1	-1,55	0,072	-3,25	0,15	15%
P0	Group Refference				

Table 4. shows that silky pudding with P3 (25:75) (7g) treatment can reduce carbohydrate levels the most that is 44% with a difference between P0 (100:0) (0g) of -3.22 and this reduction is very significant (p=0.001). To determine the differences in treatment of the three formulations, further tests were carried out using the Least Significance Difference (LSD), as shown in Table 5.

Table 5. Differences in carbohydrate levels between goat's milk substitution and mung bean flour in silky pudding.

Treatment		Mean Different	Std. Error	*p*	95% Confidence Interval	
					Lower Bound	Upper Bound
P3	P2	-0,46	0,82	0,583	-2,16	1,25
	P1	-1,67	0,82	0,054	-3,37	0,03
P2	P1	-1,21	0,82	0,153	-2,91	0,49

Table 5. shows that silky pudding treated with P3 (25:75) (7g) had a nearly significant reduction in carbohydrate levels compared to P1 (75:25) (3g) (p=0.054). Based on the LSD test, it shows that the three substitute formulations for goat's milk and mung bean flour have the same ability to reduce carbohydrates. Therefore, the choice is the formulation that has the least reduction in carbohydrates which is silky pudding with P1 (75:25) treatment (3g).

Compounds known as carbohydrates are composed of molecules containing carbon, hydrogen, and oxygen. Carbohydrates serve as a vital nutrient, primarily responsible for facilitating energy production within the human body. Every gram of carbohydrate ingested yields 4 kcal of energy, which is subsequently utilized by the body to perform diverse functions including respiration, cardiac activity, muscle contractions, and physical endeavors such as exercises or work [2].

Each substitution treatment for goat's milk and mung bean flour produced significantly different results, the higher the substitution, the lower the carbohydrate level. This research is in line with research conducted by Zaidah [27] that the carbohydrate level of 3 types of mixed mung bean flour in cookies was lower than the control due to the increased proportion of mung bean flour used.

In addition to this, the determination of carbohydrate content in the silky pudding is conducted by the utilization of the by-difference method, which is subject to the influence of various additives like protein, fat, water, and ash. Consequently, as the concentration of other nutrients increases, the carbohydrate content in the food decreases. Hence, a decrease in the levels of other essential nutrients corresponds to an increase in the carbohydrate content within the food. This aligns with the assertion made by Fatkurahman [5] that the

amounts of carbohydrates are impacted by many dietary constituents, including protein, water, fat, and ash content

3.3. Protein Digestibility

Analysis result of protein digestibility in silky pudding as shown in Figure 6.

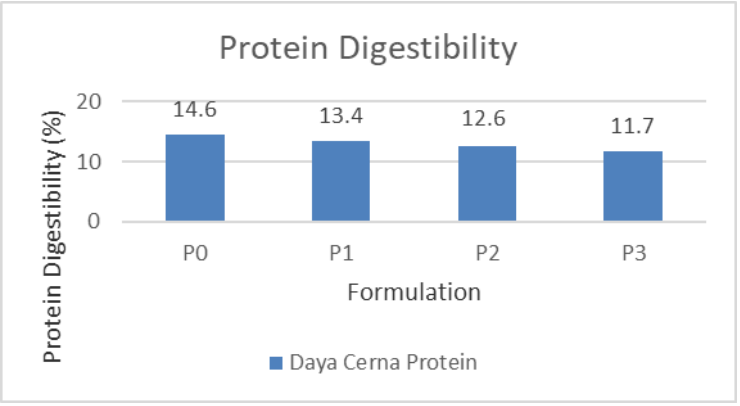

Fig. 6. Development of protein digestibility according to the substitution of goat's milk and mung bean flour in silky pudding.

Figure 6. shows that protein digestibility in silky pudding ranges from 11,7 to 14,6%. The lowest protein digestibility was found in P3 (25:75) (7g) treatment at 11,7% while the highest is in P0 (100:0) (0g) at 14,6%. The effect of various substitutions for goat's milk and mung bean flour was tested using the independent t-test, as shown in Table 6.

Table 6. The effect of goat's milk substitution and mung bean flour on protein digestibility in silky pudding.

Treatment	B	*p*	95% Confidence Interval		Partial Eta Squared
			Lower Bound	Upper Bound	
P3	-2,90	<0,001	-32,98	-25,03	92%
P2	-2,00	<0,001	-23,96	-16,01	85%
P1	-1,24	<0,001	-16,39	-8,45	68%
P0	Group Refference				

Table 6. shows that silky pudding with treatment P3 (25:75) (7g) can reduce protein digestibility the most at 92% with a difference between P0 (100:0) (0g) of -2.90 and this reduction is very significant ($p<0.001$). To determine the differences in treatment of the

three formulations, further tests were carried out using the Least Significance Difference (LSD) test, as shown in Table 7.

Table 7. Differences in protein digestibility between goat's milk substitution and mung bean flour in silky pudding.

Treatment		Mean Different	Std. Error	*p*	95% Confidence Interval	
					Lower Bound	Upper Bound
P3	P2	-902*	0,19	<0,001	-1,30	-0,50
	P1	-1.658*	0,19	<0,001	-2,06	-1,26
P2	P1	-757*	0,19	<0,001	-1,15	-0,36

Table 7. shows that the three silky pudding formulations have very significant differences in reducing protein digestibility. Based on the LSD test, it shows that the three formulations of goat's milk substitution and mung bean flour have the same ability to reduce protein digestibility. Therefore, the choice is a formulation that has higher digestibility that is silky pudding with P1 (75:25) (3g) treatment.

The digestibility of proteins refers to their capacity to undergo hydrolysis into amino acids through the action of digestive enzymes. High digestibility refers to the ability of a protein to be efficiently broken down into amino acids, resulting in a high absorption and utilization of amino acids by the body. Conversely, low digestibility indicates that the protein is not easily broken down into amino acids, leading to a low absorption and utilization of amino acids by the body. This is because a significant portion of the protein is excreted through feces [18].

Factors that influence protein digestibility include natiye made from raw legumes which will be more difficult to digest than those which have been denatured by heat. Likewise, the presence of anti-nutritional factors such as antitrypsin and anticotrypsin/hemagglutinin can affect protein digestibility. In addition, reactions between proteins with other components (reducing sugars, polyphenols, fats, and oxidation production) and additional chemicals (bases, sulfur oxide, or hydrogen peroxide) can cause a decrease in protein digestibility [23].

This decrease in protein digestibility was due to the influence of increasing total phenols. This is because phenolic compounds such as polyphenols can inhibit the activity of the trypsin enzyme [15]. This inhibition is caused by the inability of the trypsin enzyme to recognize substrates such as proteins due to the formation of a strong complex between polyphenols and proteins. This complex compound consists of hydroxyl and carboxyl groups, which makes it difficult for digestive enzymes to hydrolyze proteins [8].

4. Conclusion

This study evaluated the protein, carbohydrate, and protein digestibility of mung beans and silky pudding developed with goat's milk substitute. It was shown that the ranges of silky pudding's protein content are 3.9% to 5.7%, carbohydrate content is between 88.8% and 85.7%, and protein digestibility is between 14.6% and 11.7%. Mung bean flour and goat's milk substitute have a significant effect on the quantity of protein, carbohydrates, and protein is digestible in silky pudding.

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