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Modisco III Formulation for Combating Severe Malnutrition

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Abstract. Modisco (Modified Dietetic Skimmed Milk and Coconut Oil) is a nutritious and high-calorie formula in the form of liquid food made from skim milk or full cream, sugar, and oil or margarine. The addition of soybean flour was given to increase the protein content intended for alternative handling cases of protein energy deficiency. This study was conducted to analyze the effect of the modification of Modisco III formula by adding soybean flour to the growth of malnutrition rats. The design of this study was a pre-post test control group using 24 Wistar male rats treated with malnutrition, which was divided into four groups, namely control (-): low protein feed, control (+): standard AIN-93G feed, treatment (1): Modisco III soybean feed, and treatment (2): Modisco III soybean meal + cassava flour. Based on the analysis of variance (ANOVA) there was a significant difference on the weight and body length between group ($p < 0.0001$). The addition of soybean flour on the modified Modisco III had influenced the weight and body length ($p < 0.0001$) as well as the growth of malnutrition rats.

INTRODUCTION

Modisco is a form of liquid food made from cow's milk (skim), oil or margarine, and sugar [1]. Modisco stands for Modified Dried Skimmed Milk Coconut Oil, which was first discovered by May and Whitehead in 1973. Modisco is a food or beverage supplement that has high nutritional value, first given to children with severe nutritional disorders in Uganda, Africa, that is, children who lack protein calories [2]. Modisco has given to children with severe malnutrition carried out in stages according to the child's condition [3]. Improvement of malnutrition is characterized by weight gain and body length, which is a form of growth. Riskesdas 2018 stated that, toddlers in Indonesia who suffer from nutritional status are very thin by 4.5% Malnutrition conditions (PEM) based on body weight and length, determined based on the state of a very thin body [4].

Giving modisco to children who suffer from malnutrition as additional food adjusted to the conditions [5]. Modisco I has been given in the stabilization period (toddlers without edema); modisco II has been given in the transition period (toddler edema), and Modisco III has been given as a continuation of the gift after Modisco I and II (rehabilitation period) [6]. Modisco was first known in Indonesia with various formula names; there are Modisco ½, Modisco I, Modisco II, and Modisco III. Modisco consists of three basic formulas with the main ingredients, such as sugar, oil or margarine, and skim milk or full cream milk. The average calorie contained in modisco is 100 calories/100 cc. The nutritional content of each formula is energy (M1/2: 80 Kcal; MI: 100 Kcal; MII: 100 Kcal; MIII: 130 Kcal); protein (M1 / 2: 3.5g; MI: 3.5 g; MII: 3.5 g; MIII: 3.0 g), and fat (M1/2: 2.5 g; MI: 3.5 g; MII: 4.0 g; MIII: 7.5 g. All materials for making modisco can be obtained easily both in urban and rural areas.

Following up in handling malnutrition cases is during the rehabilitation period, therefore given Modisco Formula III that has been modified with ingredients [7]. According to existing standards, Modisco III ingredients are made from full cream milk, sugar, and margarine and 245 grams of weight containing 1300 kcal of energy. However, after being modified or replaced with the ingredients, Modisco III formula had composed of full cream milk, sugar, and

coconut oil. This material replacement was carried out to keep achieving minimal energy from sufferers of malnutrition in the transition phase that was, 100-150 kcal/Kg in every 200 grams of modisco and with not too much oil composition, so the energy produced from the modisco III modification formula was 1145 kcal with 25.1 grams of protein, 79 grams of fat, and 83.2 grams of carbohydrates. The calculation of calories from the modisco III modification were the primary data obtained from the addition of the calorie content of each ingredient in accordance with the required weight of the material [6].

Nutrient requirements for handling malnutrition in the rehabilitation phase include energy needs of 150-220 kcal/Kg/day, protein needs of 3-4 g/Kg/day, fat 30-45% of total energy and fluids of 150-200 ml/Kg/day. In the rehabilitation phase of diet therapy given is Modisco III with a protein content of 30 g/1000 mL, while to maximize protein in severe malnutrition children with a maximum body weight of 10 Kg, 40 grams of protein are required, so that the Modisco III was modified by adding soy to add protein value. Soybean is a food ingredient that contains high vegetable protein which is hypoallergenic and contains other nutrients, which are very useful to improve the nutritional status of children with PEM (Protein Energy Malnutrition) [7]. Protein in soy can function as a source of peptide, absorbed more quickly and efficiently compared to free amino acids [8]. A mixture of peptides and protein hydrolyzation is recommended as a source of nitrogen for patients suffering from malnutrition or having problems with protein digestion [9]. Peptides derived from plant foods are digested and absorbed by the intestine well and have a role in various physiological activities in the organ [10]. This study was conducted to analyze the effect of the modification of Modisco III formula by adding soybean flour on the growth of malnutrition rats.

EXPERIMENTAL DETAILS

Stage I, Preparing The Soy Modisco Formula.

- a. Materials for soy Modisco formula

TABLE 1. Materials for Modisco III Formula + Soybean Flour

Materials	Modisco III	Modisco III + Soybean
Full cream milk	120 g	102.00 g
Sugar	75 g	63.75 g
Margarin	50 g	42.5 g
Soybean Flour	-	36.75 g

- b. Tools: analytical digital scales, spoons, bowls, cups, measuring cups, pans, and stoves.

Stage II, Making The Rats Become Severe Malnutrition

This research used *Rattus norvegicus* Berkenhout male, three weeks old. The condition of severe malnutrition was made by giving cassava flour as much as 20 g/day for fourteen days *ad libitum*. (Ethical Clearance number: 415/VII/2019/Komisi Bioetik)

Stage III, Treatment

Twenty four rats were used in this study with the pre-post test control group design. Those rats were grouped into four each with six tails; *i.e.* control group (-), malnutrition condition (cassava feed), control (+) (AIN93 standard feed), treatment group 1 (soy modisco feed), and treatment group 2 (soy modisco feed + cassava). Those rats were kept in individual cages for 28 days in the laboratory of the Center for Food and Nutrition Studies at Universitas Gadjah Mada, Yogyakarta.

Stage IV, Analysis

Weight and length data were analyzed by using Anova with a significance of 95%.

RESULTS AND DISCUSSION

This research included the making of feed and maintenance of rats carried out by starting from the adaptation phase, malnutrition phase until the treatment phase. To find out the growth of the rats, the weight of the rats was measured and measurements of body length were conducted both in the malnutrition phase and intervention phase, each phase carried out maintenance for 14 days.

Feed Composition

The composition of feed that had given to each group is listed in Table 2.

TABLE 2. Composition of rat feed

Group	Control (-)	Control (+)	Treatment 1	Treatment 2
Energy (Kcal)	363.0	376.6	391.9	386.1
Protein (g)	1.1	18.2	16.3	13.26
Fat (g)	0.6	6.9	26.3	21.04

Table 2 shows that there are differences in the composition of energy, protein and fat. The lowest composition is in the Control group (-). This group was a severe malnutrition group; the feed was in the form of cassava flour to condition the PEM feed (protein energy malnutrition). The Control Group (+) was a normal growth group, because it had given a standard feed, that is AIN93. Treatment Group 1 and Treatment 2 were the rehabilitation group, fed with modisco + soybeans and modisco + cassava. Modisco + soybean meal had the highest energy, protein, and fat composition compared to the other three groups.

Body Weight

TABLE 3. Body weight of rats on malnutrition phase

Group	Pre \pm SD (g)	Post \pm SD (g)	% Enhancement *
Control (-)	90.67 \pm 3.39	95.83 \pm 3.31	5.7 ^a
Control (+)	94.67 \pm 3.67	106.33 \pm 3.88	12.3 ^b
Treatment 1	94.33 \pm 3.20	99.83 \pm 2.79	5.8 ^a
Treatment 2	93.67 \pm 3.01	99.00 \pm 2.97	5.7 ^a

* the numbers followed by different superscript letters, indicating there was a significant of difference increase in weight

In the malnutrition phase, the highest of weight gain was in the Control group (+), the group that was given AIN93 standard feed. The other groups showed almost the same percentage of weight gain.

TABLE 4. Body weight of rats on intervention phase

Group	Pre \pm SD (g)	Post \pm SD (g)	% Enhancement*
Control (-)	96.33 \pm 3.33	98.67 \pm 3.14	2.4 ^a
Control (+)	108.50 \pm 3.45	193.50 \pm 3.61	78.3 ^b
Treatment 1	100.67 \pm 2.58	156.00 \pm 4.42	54.9 ^c
Treatment 2	99.83 \pm 2.78	110.00 \pm 2.82	10.1 ^d

* the numbers followed by different superscript letters, indicating there was a significant of difference increase in weight

In the intervention phase, the highest of weight gain was in the Control group (+), the group that was given AIN93 standard feed; the next enhancement was in the Treatment group 1 (modisco + soy) and Treatment 2 (modisco + cassava). The lowest weight gain was in Group (-), cassava feed only. The weight gain of the group given with modisco + soybean (Treatment 1, rehabilitation) was 22.9 times compared to the group given cassava (Control (-), malnutrition). All groups showed that a significantly different weight gain.

Body Length

TABLE 5. Body length of rats on malnutrition phase

Group	Pre ± SD (cm)	Post ± SD (cm)	% Enhancement*
Control (-)	10.35 ± 0.13	10.40 ± 0.12	0.5 ^a
Control (+)	10.23 ± 0.04	11.13 ± 0.08	8.9 ^b
Treatment 1	10.40 ± 0.24	11.10 ± 0.23	6.7 ^c
Treatment 2	10.39 ± 0.23	10.79 ± 0.22	3.8 ^d

* the numbers followed by different superscript letters, indicating there was a significant of difference increase in length

TABLE 6. Body length of rats on intervention phase

Group	Pre ± SD (cm)	Post ± SD (cm)	% Enhancement*
Control (-)	10.42 ± 0.12	10.48 ± 0.12	0.62 ^a
Control (+)	11.50 ± 3.45	12.80 ± 0.04	11.33 ^b
Treatment 1	11.47 ± 2.58	12.56 ± 0.24	9.44 ^c
Treatment 2	10.98 ± 2.79	11.63 ± 0.24	5.99 ^d

* the numbers followed by different superscript letters, indicating there was a significant of difference increase in length

All groups in both the malnutrition had showed significant differences from each other. Enhancement body length of the group that was given with modisco + soybeans (Treatment 1, rehabilitation) by 15.2 times compared to the group that was given with cassava (Control (-), malnutrition).

Food composition had been given differently to see the effect of giving Modisco III modification formula to the growth of rats that had been malnourished. This condition made the rats in a state of malnutrition, because the nutritional content, especially cassava flour protein is very low compared to AIN93 standard feed which is 1.1 compared to 18.2 (6.0% of standard requirements). This condition results in protein deficient rats, so to overcome this need to increase food intake with adequate protein content [5]. Modisco III modified soy flour was intended to improve the poor nutritional conditions at the rehabilitation stage, where the protein content was 16.3g compared to 18.2g (89.6% of standard requirements). This condition will gradually improve its nutritional status by measuring anthropometry through weight weighing and body length measurements. Weight is a measure of body volume, covering all of body dimensions, including body length. Measurement of body weight is a manifestation of growth. Therefore, weight gain indicates how fast growth has due to food intake in a certain period [11].

Based on the different test results between groups, there were differences in weight gain (Table 4) and body length (Table 6). Modisco + soybean formula feeding had been given to Treatment 1 group (rehabilitation) that significantly affected the weight (22.9 times) and body length (15.2 times) enhancement, compared to the group had been fed with cassava (malnutrition). Weight and length measurements were intended to measure growth. Therefore, it means that there was an effect of giving soy Modisco on the growth of severe malnutrition rats. The enhancement of body weight and length of rats after the intervention was related to the presence of macro nutrient content there were protein, fat and carbohydrates in the Modisco soy formula. These macro nutrients produce the energy needed by the body to carry out activities. The effect of modisco soybean on body weight and length is based on the nutrient content in it, especially protein. The main function of proteins is to build tissues, such as muscles, bones, enzymes, and red blood cells. Protein supply from food was needed for bone formation; amino acids in protein are needed for intracellular and extra cellular synthesis [9]. The protein in soybeanfunctions as a builder, maintainer of cells and body tissues, and helps in the metabolism of the immune system. Soybeans contain of lysine, amino acids of which role together with arginine, glycine and ornitin is activating growth hormone (HGH- Human Growth Hormon). This growth hormone is responsible for promoting muscle development, burning fat, and regulating the immune system [12]. Modisco soybean also contains food fiber, vitamins, and minerals needed by the body [13]. The amount and type of Modisco adjusted for cases of lack of weight or severe malnutrition that is different in each child divided into several phases; there are low, medium and severe malnutrition. Modisco soybean is a modification of Modisco III so that it can be given to children in the rehabilitation phase. The need for protein in children with poor nutrition in the rehabilitation phase is 3-4 g/Kg/day, whereas in basic modisco III it is 30 g/1000 mL, and protein in soybean Modisco is 39.17 g/1000 mL, so that Modisco soybean is recommended for under-nutrition and malnutrition conditions in the rehabilitation phase. Modisco soybean is a modification of Modisco III, so that this study has given to the rats in the rehabilitation phase

or severe malnutrition condition. Other researchers reported that there was a correlation between protein intake and an increase in body mass index, where BMI is influenced by body weight and body length. It was reported that protein intake stimulates the release of growth hormone which can increase growth, muscle mass, and fat [7].

SUMMARY

Modisco III administration on severe malnutrition *Rattus norvegicus* Berkenhout male for 14 days had increased body weight by 22.9 times and body length by 15.2 times compared to rats had been fed with cassava (malnutrition phase). The feeding of Modisco + soybean had an effect on the growth of *Rattus norvegicus* Berkenhout male severe malnutrition.

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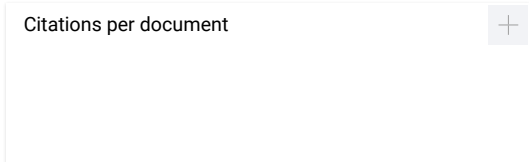
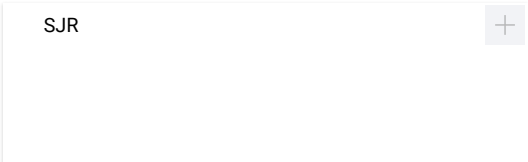
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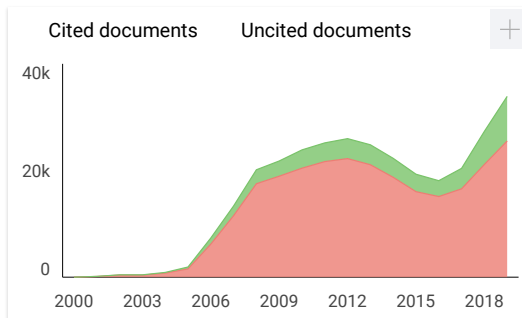
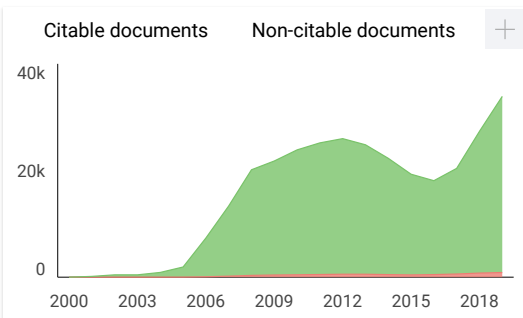
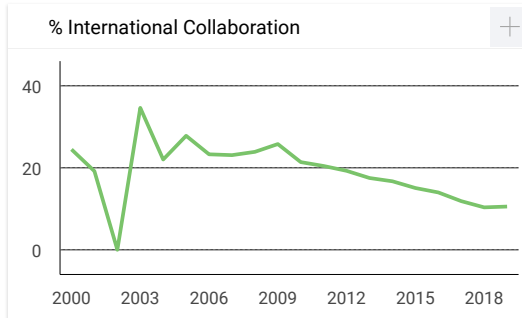
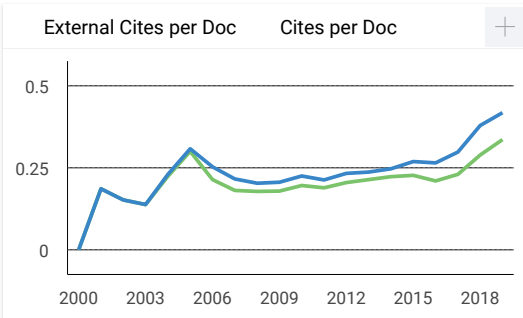
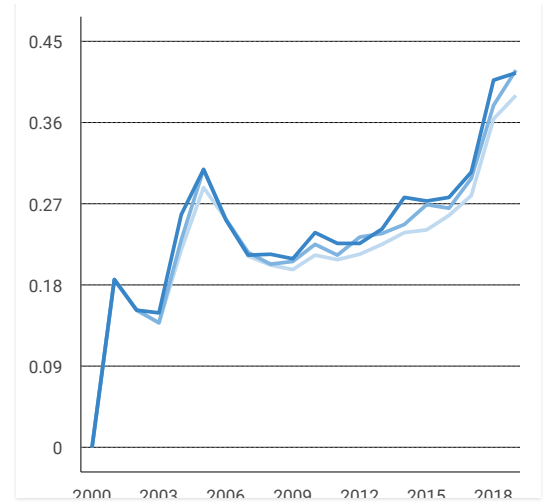
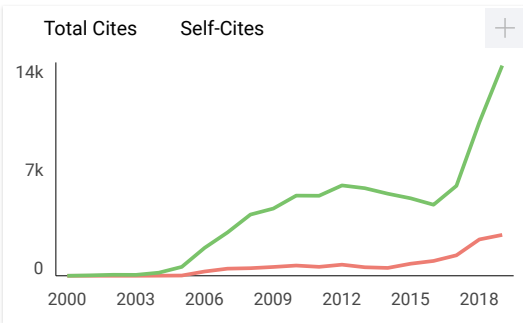
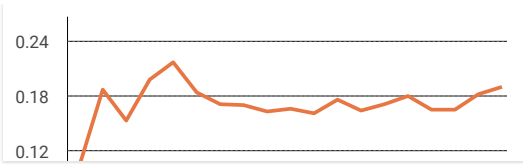
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