### In Vitro Carbohydrate Digestibility and Total Gas Production of Goat Milk Replacer Based on *Surimi* Waste Powder and Ketchup Dregs Powder

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#### Abstract

This research aimed to evaluate the use of *surimi* waste powder and ketchup dregs powder as main material of milk replacer for dairy goat based on carbohydrate digestibility and total gas production. The research was experimentally carried out by using in vitro method. Material used in this research is rumen fluids taken from abbatoir Sokaraja, immediately after slaughter. The data analysis was using completely randomized design (CRD) for carbohydrate digestibility with 4 treatments and 5 replicates of each. The results showed that the milk replacer has a significant effect on carbohydrate digestibility and total gas production (P <0.01). The research concludes that milkbased replacer of *surimi* waste powder and ketchup dregs powder has not been able to replace goat milk, because its carbohydrate digestibility is low and total gas production is unstable at the beginning and the end of observation.

Keywords: dairy goat, milk replacer, *surimi* waste powder, ketchup dregs powder

#### Introduction

Milk production is the main income earned by dairy goat farmers every day. Milk is produced from the female goat that is being nurtured, but in this early lactation period the farmer cannot collect the milk from the goat because the goat is still feeding her milk to the lamb. The lamb needs milk intake from its mother until 60 to 90 days after birth. The goat milk necessary for the age of 8-34 days old is 1.2 liters/head/day, the age of 35 to 70 days old is 1.6 liters/head/day and the age of 71to 90 days old is 2 liters/head/day, so during preweaning period, it requires 131 liters of milk or 1.5 liters/head/day (Devendra and Burns, 1983). This is less efficient and can lead to a decline in farmers' income in marketing their milk, it means that farmers didn't get milk as long as they feed to the mother. The maintenance system that can be used in dealing with these problems is by using a substitute for milk or known as milk replacer (Keskin and Bicer, 2002).

Milk replacer (MR) given to the lamb must have biological or nutritional value that is not much different from the mother's milk (Luo et al., 2000). The making of MR must also have a higher economic value than fresh milk, one of which is by utilizing *surimi* waste and industrial waste making soy sauce. *Surimi* waste is the residual production of *surimi* or fish fillets in the form of head, bone, tail and fins (Setivono and Heru, 2006), with 57% of the total fish used (Archer et al., 2001). Surimi waste is usually processed into flour with a high protein content potential of 36.45% (Suparwi, 2012). The SOV sauce processing industry produces solid waste in the form of soy sauce. According to Utami et al. (2012), ketchup dreas powder has an average protein content of 33.01% and is similar to the results of previous studies of 35% (Suprapto, 2001). The combination of the use of animal protein and vegetable protein with appropriate balance is expected to be used as a good MR constituent.

Milk replacer is a substitute for milk with high protein content. MR must be able to be digested properly and it has high digestibility carbohydrate and gas production, especially gas from the Volatile Fatty Acid (VFA) class. The use of ketchup dregs powder and *surimi* waste as a source of protein will directly increase the protein content in milk replacer. According to Suparwi (2012), Dry matter (DM) content of surimi waste powder is 92% with a protein content of 36.45% and DM of soybean pulp flour is 44.76% with a protein content of 33.01%. The use of these two ingredients will also increase microbial activity in rumen fluid so that it is positively correlated to

increased carbohydrate digestibility and total gas production of milk replacer.

On the other hand, not only a high content of DM and protein are *surimi* and soy sauce, but also they have a high fiber content compared to the crude fiber content of goat milk (0.41%). *Surimi* waste powder contains crude fiber of 10.96% and ketchup dregs powder of 17.10%. The high content of crude fiber in the ingredients of milk replacer can inhibit carbohydrate digestion and total gas production. Therefore, this study is expected to be able to answer about the use of *surimi* waste powder and

ketchup dregs powder as the basic material for making milk replacer with formulations.

#### **Materials and Methods**

The material used in the study was rumen goat liquid taken immediately after being slaughtered at Sokaraja Animal Slaughterhouse. The ingredients for milk replacer consist of *surimi* waste powder, ketchup dregs powder, coconut cake, tapioca flour, skim milk, minerals and probiotics. Milk replacer formulas are presented in Table 1.

Table 1. Formula MR0, MR1, MR2 dan MR3.					
Matorial		Treat	ment		
Material	MR0 (%)	MR1 (%)	MR2 (%)	MR3 (%)	
Goat Milk	100	0	0	0	
Surimi Waste Powder*	0	30	20	10	
Ketchup Dregs Powder	0	10	20	30	
Skim Milk Powder*	0	30	30	30	
Coconut Cake*	0	20	20	20	
Tapioca Flour	0	9,4	9,4	9,4	
Minerals	0	0,5	0,5	0,5	
Probiotics	0	0,1	0,1	0,1	
Total	100	100	100	100	
Protein	26,96	28,31	27,66	26,93	
Fat	28,95	9,83	9,79	9,75	
Crude Fiber	0,41	10,03	10,30	10,61	
Nitrogen Free Extract (NFE)	35,44	34,91	38,17	41,81	

Note: Calculation of MR nutrient levels based on the proximate analysis of each ingredient. Proximate analysis of *surimi* waste powder, skim milk and coconut cake (Suparwi, 2012); Proximate analysis of ketchup dregs powder (Utami *et al.*, 2012); Proximate analysis of tapioca flour (Adi *et al.*, 2013).

The study was conducted using experimental methods in vitro (Tilley and Terry, 1963). The experimental design used was Completely Randomized Design (CRD)

for carbohydrate digestibility with 4 treatments and 5 replications and Random Group Plan for Gas Production

Total with 4 treatments divided into 5 blocks. The treatments that will be tested are:

MR<sub>0</sub> : Goat milk (control)

MR<sub>1</sub> : Basal Material 60% + SWP 30% + KDP 10%

MR<sub>2</sub> : Basal Material 60% + SWP 20% + KDP 20%

MR<sub>3</sub> : Basal Material 60% + SWP 10% + KDP 30%

Note: MR = *Milk Replacer*, SWP = *Surimi* Waste Powder, KDP = Ketchup Dregs Powder, Basal Material (30 % skim milk powder, 20% Coconut cake, 9,4% tapioca flour, 0,5% mineral dan 0,1% probiotics).

The variables measured in this study were carbohydrate digestibility and total gas production which were analyzed using a two-level method modification technique (Tilley and Terry, 1963).

#### **Results and Discussion**

Research on carbohydrate digestibility and total gas production of goat milk replacer based on *surimi* waste powder and ketchup dregs powder was carried out in vitro, using 3 different formulations and compared with powdered goat milk as a control. Each formula based on proximate

analysis (Henneberg and Stohmann, 1860)							
has	different	nutrient	levels	that	is		
prese	nted	in	Table		2.		

Table	2. Proximate	e analys	is formula	a MR0 (con	ntrol), MR1, MR2	2, dan MR3.
		_	-		-	

Formula	DM %	Protein %	Fat%	CF%	Ash %	NFE %
MR0	93,78	26,96	28,95	0,41	8,23	35,44
MR1	89,98	30,62	10,39	6,56	17,22	32,22
MR2	91,31	29,73	13,73	8,66	13,29	34,60
MR3	92,76	28,60	17,28	11,45	11,45	30,09

Note: MRO (control) goat milk powder, MR1: 60% basal material (BM) + 30% Surimi Waste Powder (SWP) + 10% Ketchup Dregs Powder (KDP), MR2: 60% BM + 20% SWP + 20% KDP, MR3: 60% BM + 10% SWP + 30% KDP.

Based on the proximate analysis (Table 2), it can be seen that MR1 is a formulation with the highest protein content of 30.62% higher than the other two formulations and controls. This is because the composition of surimi waste powder and ketchup dregs powder is different in each formula. MR1 is composed of 60% basal ingredients (30% skim milk, 20% coconut cake, 9.4% tapioca flour, 0.1% probiotics and 0.5% minerals) with addition 30% surimi waste powder and 10% ketchup dregs powder, MR2 is composed of 60% basal incredients with addition 20% surimi waste powder and 20% soy sauce flour, while MR3 is composed of 60% basal ingredients with addition 10% surimi waste powder and 30% ketchup dregs powder. The higher percentage of surimi waste usage will increase the protein content of the MR formula. This happens because surimi waste powder has a high protein content of 36.45% (Suparwi, 2012), while ketchup dregs powder has a lower protein content than surimi waste powder, which is 33.01% (Utami et.al., 2012)

The MR3 formula has the highest fat and crude fiber content compared to two other formulas, but MR3 fat content is lower than the control. The MR3 formula contains 30% soy sauce flour which causes an increasing in the fat content and crude fiber of the formula. Ketchup pulp has a fat content of 20.73% and crude fiber of 17.10% higher than the *surimi* waste powder containing of 15.46% fat and crude fiber of 10.96% (Utami *et.al.*, 2012) . This shows that the greater use of *surimi* waste powder will increase the fat content and crude fiber of the MR formula.

# Carbohydrate digestibility

The results of the analysis variance showed that milk replacer formulas has a very significant effect (P <0.01) on carbohydrate digestibility of rumen fluid in vitro. This is appropriate to the results of Utami et al. (2012) which showed that milkbased substitutes for surimi waste powder and ketchup dregs powder have high dry digestibility. drv matter High matter diaestibility can illustrate the hiah digestibility of carbohydrate. In addition, the protein content of each treatment was also high, with an average value of 28.98%. Syamsi et al. (2018) stated that feed protein is important in relation to increasing microbial protein synthesis through increased energy use and carbon skeleton providers. This is in line with the increase in feed digestibility, because the rumen microbes are the agents of digestion in the rumen. Then Waldi et al. (2017) added that the degradation kinetics between protein and energy is very important, whereas, if the degradation kinetics between the two is suitable, it will provide simultaneous energy supply and protein for microbial protein synthesis.

Based on the analysis of real honest differences (Table 3), the average from highest to lowest carbohydrate digestionis respectively MR0 (94.17  $\pm$  0.25%), MR1 (62.83  $\pm$  0.34%), MR3 (51.96  $\pm$  0.53%), and MR2 (51.95  $\pm$  0.47%). The control treatment (MR0) had the highest carbohydrate digestibility compared to all treatments, because the control treatment was goat milk powder. According to Turner (2006), milk contains 4.6% carbohydrates in the form of lactose (glucose and galactose) and milk is a perfect food ingredient because all the nutrient levels is able to be digested up to 100% in the digestive tract. Based on the average carbohydrate digestibility and BNJ test, MR1 has a higher digestibility compared to MR2 and MR3. The MR1 formula has the lowest crude fiber (CF) content (6.56%) compared to MR2 (8.66%) and MR3 (11.45%). CF levels in milk replacer formulas are affected by the use of ketchup dregs powder. The soy sauce used in milk replacer formulas is the

result of grinding the waste in the form of soybean seeds along with the skin. The level of CF soy sauce flour is strongly affected by soybean skin. The percentage of soybean skin in each soybean grain is 7.3% and contains 36.4% CF (Murni. et.al. 2008). Therefore, the higher the use of soy sauce dreas the higher the level of CF milk replacer. According to Wijayanti et.al. (2012), the digestibility of a feed ingredient is affected by the percentage of crude fiber (CF) in it. Therefore, the higher the CF level, the nutrient digestion including carbohydrates will decrease.

Table 3. Further test data is significantly different from the formula carbohydrate digestibility MR0 (kontrol) MR1 MR2 dan MR3

Parameter	MR0	MR1	MR2	MR3			
carbohydrate digestibility (%)	94,17±0,25 <sup>ª</sup>	62,83±0,34 <sup>b</sup>	44,23±0,53 <sup>d</sup>	51,96±0,47 <sup>c</sup>			
Total Gas Production (%)	22,45±0,62 <sup>b</sup>	18,05±0,62 <sup>°</sup>	41,47±0,48 <sup>a</sup>	42,17±0,79 <sup>a</sup>			

Note: MRO (control) goat milk powder, MR1: 60% basal material (BM) + 30% Surimi Waste Powder (SWP) + 10% Ketchup Dregs Powder (KDP), MR2: 60% BM + 20% SWP + 20% KDP, MR3: 60% BM + 10%SWP + 30% KDP.

Sovbean skin is a group of fiber carbohydrates which the digestibility is carbohvdrates lower than non-fiber (Rimbawanto and Ning, 2000). The percentage of the use of ketchup dregs powder in milk replacer formula increases carbohydrate content of fiber, so the digestibility of milk replacer with a high content of SOV sauce will reduce carbohydrate digestibility. The MR1 formula has the highest carbohydrate digestibility (62.83%), because it only used 10% ketchup dregs powder, but MR3 has a higher carbohydrate digestibility than MR2 This shows (51.96%> 44.23%). that carbohydrate digestibility is not only affected by CF but also due to other factors such as NFE.

MR2 extract without nitrogen (NFE) was the highest among treatments (MR2 34.60%> MR1 32.22%> MR3 30.09%). Soybean seed skin which is ground in ketchup dregs powder consists of 61% partitioned cell walls of 16.4% hemicellulose, 42.6% cellulose and 2% lignin (Murni *et.al*, 2008). These substances are part of NFE which has a bad effect on digestibility. Lignin with cellulose in the cell wall binds to protein and inhibits the action of the microbial protease enzyme to hydrolyze it. This causes microbial synthesis to become inhibited and small microbial populations cause carbohydrate digestibility to be low (Rimbawanto and Ning, 2000). MR1 has the lowest CF and lower NFE compared to MR2, so it has a high carbohydrate digestibility compared to MR2 and MR3. Whereas MR2 has a lower carbohydrate digestibility compared to MR1 and MR3, although MR3 levels are higher than MR2, NFE levels on MR2 are higher than MR1 and MR3.

In addition to CF and lignin factors, ketchup dregs powder also contains antinutrients, especially antitrypsin and phytic acid. Antitrypsin and phytic acid have a role to block the enzyme trypsin (protease) in hydrolyzing proteins (Santoso, 2005). Protease enzymes can also be produced by rumen microbes and their performance can also be hindered by the presence of these two antinutrients. The process of inhibited protein hydrolysis causes the process of synthesis of microbes to be inhibited, so population that the microbial of carbohvdrate degradation becomes reduced and obtains in reduced carbohydrate digestibility. Ketchup dregs powder actually has undergone a process of heating, fermentation and grinding.

These processes can eliminate the dregs antinutrient content in ketchup powder. Therefore. the effect of antinutrients on carbohydrate digestibility in this study is very small.

### **Total Gas Production**

Total gas production is an indicator of fermentative activity by microbes in the rumen. High total gas production when incubating in vitro with rumen fluid can describe digestible nutrients (Budiyanto, 2009). Fermentation in the rumen is associated with the formation of gases namely volatile fatty acids (VFA), CH4, CO2, N2, NH3 and O2. The gas production will later assume the digestibility of the feed ingredients incubated in vitro. Nutrient digestion in the digestive process is directly proportional to total gas production.

Based on the results of the analysis variance, the type of milk replacer formula has a very significant effect (P < 0.01) on the production of total rumen fluid gas in vitro. This shows that MR based on *surimi* waste powder and ketchup dregs powder can affect the total gas production in the rumen. This is in line with the high digestibility of dry matter Utami *et al.* (2012),

organic ingredients, and milk replacer carbohydrates. Based on honest real difference test (Table 3), the highest total gas production is on MR3 and it is not significantly different to MR2 with the average value of each treatment ( $42.17 \pm$ 0.79% and  $41.468 \pm 0.482\%$ ), but different to the MR1 ( $18.05 \pm 0.622\%$ ) and MR0 ( $22.45 \pm 0.62\%$ ), lowest total gas production.

According to Tanuwiria et al. (2010). feed ingredients with high carbohydrate levels will produce high VFA and become a considerable part of the total gas to be measured. Tillman et al. (1998), stated that carbohydrates in partitioned analysis become CF and NFE, therefore it can be seen that the carbohydrate levels in MR formulations are respectively MR3 41.54%, MR2 43.26% and MR1 38.78%, whereas carbohydrate levels in Control (MRO) was 35.85%. Total gas production is affected by carbohydrate digestibility, protein hydrolysis by microbes and by-products of microbial synthesis. MR0 and MR1 have very fermentable carbohydrates (non-fiber MR2 carbohydrates), while and MR3 contain more fiber carbohydrates which are harder degrade. to



Fig 1. Initial and final gas production

Figure 1 shows that the average initial gas production at MR0 and MR1 is very high compared to MR3 and MR2. Gas production that is too high at the beginning of the observation caused the substrate to be degraded by microorganisms to become small and then the subsequent gas production will be reduced. This also caused the difference between initial gas production and final gas production (24 hours) to be small and the analysis of total gas production to be low. The different occured in MR3 and MR2, gas production at the beginning of the observation was not too high, it happened because the crude fiber content on MR3 and MR2 (8.66% and 11.45%) was higher than MR0 and MR1, so it was less fermentable. This causes microbial performance to degrade the substrate to be slow and the accumulation of gas from metabolism slowly becomes high.

According to Budiyanto (2009), the factors that affected total gas not only come from the degradation of carbohydrates into VFA, but also influenced by protein content of feed ingredients. The higher the level of substrate protein or feed ingredients, the lower the total gas production. High levels of protein will increase the production of NH<sub>3</sub> and VFA followed by an increase in the number of microbes. The gas produced will be used in the process of microbial protein synthesis, where  $NH_3$  will react with  $C0_2$ become, therefore gas production will decrease. This is in line with the results of research showing that MR1 has the lowest production compared das to other treatments, MR1 protein content is 30.62%.

# Conclusion

Milk-based replacer based on *surimi* waste powder and soy sauce dreg flour has not been able to replace goat milk, because the carbohydrate digestibility is low and gas production is high, but slower to reach it.

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