Effect of Yeast *Saccharomyces cerevisiae* Addition to Lactating Dairy Cows Ration Upon Milk Production and Composition

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Abstract. On farm level, the price of milk is affected by its fat content. On the other hand, improving milk quality by the use of better ration economically is not feasible. The problem is how to find an appropriate, easily found, relatively cheap and efficient ration for producing better quantity and quality of milk. An experimental research was conducted using *Saccharomyces cerevisiae* yeast in lactating dairy cows ration, in a 4x4 Latin Square Design, with animal trial as column and trial period as row. Each trial period consisted of 14-day preliminary and 7-day trial period (collection period). The treatment to be tested were four levels of yeast addition, namely : 0, 5, 10 and 15 g/cow/day. The variables measured were daily milk production (4% FCM) and milk composition (solid non fat, fat, protein, lactose). The result showed that the addition of yeast had no significant effect on milk production and milk composition, but tended to increase milk fat in which the highest fat content of 5.13 % was achieved when 8.5 g/cow/day was suplemented. The average milk production, solid non fat, lactose, fat, and protein were 9.55 kg/day, 8.70%, 3.99%, 4.50% and 0.13%, respectively. Based on all measured variables, it can be concluded that the addition of yeast *Saccharomyces cerevisiae* up to 15 g/cow/day to lactating dairy cows ration did not effectively improve milk production and milk composition.

Key words: yeast addition, milk production, milk composition.

Abstrak. Penentuan harga susu di tingkat peternak sangat dipengaruhi oleh kadar lemak susu. Perbaikan komposisi susu dengan peningkatan kualitas pakan sulit dilakukan, karena tidak ekonomis. Oleh karena itu perlu dicari ransum yang murah, mudah didapat dan efisien untuk meningkatkan produksi dan komposisi susu. Suatu penelitian telah dilakukan dengan menggunakan ragi *Saccharomyces cerevisiae* dalam ransum sapi perah laktasi. Penelitian dilaksanakan dengan metode eksperimental, menggunakan Rancangan Bujur Sangkar Latin 4x4. Hewan percobaan sebagai kolom dan periode percobaan sebagai lajur. Setiap periode percobaan terdiri atas 14 hari masa preliminari dan 7 hari percobaan (masa koleksi). Perlakuan yang diuji adalah 4 taraf penambahan ragi *Saccharomyces cerevisiae* : 0, 5, 10, dan 15 gr/ekor/hari. Peubah respon yang diamati adalah produksi susu harian (4% FCM) dan komposisi susu (BKTL=Bahan Kering Tanpa Lemak, lemak, protein dan laktosa). Hasil penelitian menunjukkan bahwa penambahan ragi tidak berpengaruh nyata terhadap produksi 4% FCM (Fat Corrected Milk) maupun komposisi susu, tetapi cenderung meningkatkan lemak susu dan mencapai kadar tertinggi 5,13% pada penambahan ragi 8,50 g/ekor/hari. Rataan produksi susu 9,55 kg/hari, BKTL (Bahan Kering Tanpa Lemak) 8,70 %, laktosa 3,99%, lemak 4,50% dan protein 0,13%. Berdasarkan semua peubah respon yang diukur dapat disimpulkan bahwa penambahan ragi *Saccharomyces cerevisiae* sampai 15 gr/ekor/hari belum berhasil memperbaiki produksi dan komposisi susu.

Kata kunci : penambahan ragi, produksi susu, komposisi susu.

Introduction

Milk pricing at the farmer level is strongly influenced by the milk fat content. Efforts to increase milk composition can be done by improving or enhancing the quality of the rations. This is not usually in balanced with the farmers' revenue, thereby difficult to apply (Suwandyastuti et al., 1993).

Dairy cattle ration on small scale farming system usually contains lower energy and protein, due to its high crude fiber content. The addition of concentrate to improve the quality of ration given before forages can decrease ruminal pH below normal, resulting in a decrease of fibrolitic bacteria (Back et al., 2007). Microbial rumen population can be controlled by adding microbes to the ration

(Dawson et al., 1990), so that the products of rumen fermentation, the proportion of Volatile Fatty Acid (VFA) can be optimized, and the production of methane and ammonia in the rumen can be reduced. Control on the pattern of fermentation can also increase the population of fibrolitic bacteria to make a more efficient fermentation process in rumen (Dolezal et al., 2005) and the *Saccharomyces cerevisiae* culture supplementation in rumen ecosystem also facilitated microbial growth and improved activity of short chain polysaccharides degrading micro-organism (Tripathi and Karim, 2011).

Fat and protein content of milk depend on the feed composition provided to the animal, as well as the availability of energy and protein in the ration. Interactions between the physical form of feed ingredients and chemical composition, microbial populations and fermentation processes that occur in the rumen and post-ruminal digestion process will affect the supply of nutrients to the udder gland, as a precursor of milk components (Back et al., 2007; DeVries and Chevaux, 2014)

Optimum efficiency of feed utilization was possible by controling the pattern of rumen fermentation and increasing the microbial population, for example yeast. Therefore, the research was conducted to: (1) assess the effect of yeast *Saccharomyces cerevisiae* application in lactating dairy cattle rations on milk production and its composition, (2) determine the level of use of yeast to get the optimum of milk production and its composition.

The success of this research was expected to provide several benefits, among which were (1) scientific information, particularly in food science and nutrition of ruminants and (2) fixing the pattern of fermentation in the rumen, especially fibrolitic process in an effort to increase the production and composition of milk with low cost and ease in its application.

Materials and Methods

Expertimental research was conducted using a 4x4 Latin Square Design (Gill, 1978). Trial animals, lactating dairy cows of 2nd lactation served as row and trial periods as column. Each trial period consisted of 14-day preliminary and 7-day observations. The treatments tested were 4 levels of addition of yeast *Saccharomyces cerevisiae* in the ration, namely: R0 = 0, R1 = 5, R2 = 10, and R3 = 15 g/cow/day. Response variables observed were daily milk production and milk composition, namely: Dry Mater (DM), Non-fat Dry Mater (NFDM), Fat, Protein, Lactose and Gravity Index (GI). Milk fat was determined through Gerber method, protein through formal titration and lactose through titration.

Analysis of variance was performed to assess the effect of treatment variables on the observed variables, following a mathematical model (Snedecor and Cohran, 1989): $Y_{ijk} = \mu + H_i + R_j + P_k + \Sigma_{ijk}$ (i, j, k, = 1, 2, 3, 4). Where Y_{ijk}= observed variables on ith animal, jth treament of kth trial period; μ = general mean; H_i = effect of the ith animal; R_j = effect of jth treatment; Pk = effect of the kth trial period; Σ_{ijk} = residual effect of the ith animal, jth treatment, and kth trial period

Results and Discussion

Milk synthesis, milk composition, relationship between precursor with its product, and path metabolism in the udder have been widely studied. The main determining factor in the biological processes in the udder gland was the nutrients intake and hormonal mechanisms. However, the number of udder gland cells and the proportion of glandular tissue with connective tissue on each cow was different. The formation rate of secretory cell number in the udder gland depended on the initial cell number, as well as

Tabel 1. Mean of milk production and its composition

	Milking	Treatment rations			
		R_0	R_1	R_2	R_3
Milk production (kg/day)		9.589	9.520	9.474	9.723
DM (%)	Morning	12.81	12.69	12.61	12.64
	Afternoon	14.08	13.78	13.66	13.84
NFDM (%)	Morning	8.83	8.62	8.69	8.69
	Afternoon	8.80	8.60	8.69	8.71
Fat (%)	Morning	3.98	4.60	3.92	3.92
	Afternoon	5.22	5.18	5.01	5.13
Protein (%)	Morning	0.12	0.12	0.12	0.12
	Afternoon	0.13	0.12	0.12	0.12
Lactose (%)	Morning	3.43	4.07	4.05	3.28
	Afternoon	4.04	4.29	3.92	3.88
Gravity Index	Morning	1.03	1.03	1.03	1.03
	Afternoon	1.03	1.03	1.03	1.03
K (ppm)		242.1	234.6	239.1	239.3
Na (ppm)		55.3	54.8	54.0	53.7
C1 (ppm)		206.2	195.8	221.9	197.1
Ca (ppm)		64.9	62.2	62.5	61.6
P (ppm)		198.2	187.2	184.0	191.3
Mg (ppm)		30.8	30.3	30.0	29.7
S (ppm)		8.6	9.3	9.8	9.5
Fe (ppm)		0.2	0.2	0.2	0.2
Cu (ppm)		0.1	0.1	0.1	0.1
Zn (ppm)		1.9	1.7	1.9	1.8
Mn (ppm)		0.03	0.03	0.03	0.03

Saccharomyces cerevisiae in the ration, R0 = 0, R1 = 5, R2 = 10, and R3 = 15 g/cow/day; DM = Dry Matter, NFDM = Non-fat Dry Matter

Table 2. Summary of anova of milk production and its composition

Source of Variation	Milk Production	Milking	DM	NFDM	Fat	Protein	Lactose	GI
Animal	105.61**	Morning	10.18**	3.45	13.54**	3.20	0.91	0.20
		Afternoon	11.56**	23.46**	14.01**	2.58	0.89	0.50
Period	15.11**	Morning	6.95*	2.66	5.51*	13.76**	0.49	0.20
		Afternoon	7.06**	19.76**	8.66*	13.97**	0.88	0.75
Treatment	0.39**	Morning	0.89	3.24	0.77	0.37	2.24	2.20
		Afternoon	1.34	18.03**	0.59	0.50	0.24	1.25

DM = Dry Matter, NFDM = Non-fat Dry Matter; *) 5% significant level; **)1 % significant level

nutrients and hormones support. Although nutrients available for the udder gland was unlimited, the ability of udder gland to uptake the metabolites from *pudica externa* blood remained limited (France and Thornley, 1984; Suwandyastuti and Rimbawanto, 1990; Suwandyastuti, 2012).

The rate of nutrients uptake from the blood, shape changes or synthesis of milk components by udder secretory cells and their secretion into the *lumen aveoli*, were a physiologic mechanism that regulated the level of milk production (France and Thornley, 1984; Foley et al., 1978; Suwandyastuti and Rimbawanto, 1990; Walstra and Jennes, 1984). In this experiment the addition of yeast culture of 15 g/head/day tended to have no effect on daily milk production, although the highest milk production of 9.72 kg/day was achieved by the highest level of the yeast addition or 15 g/cow/day. The amount of milk secretion rate depended on the number and activity of

Tabel 3. Relationship between the level of yeast addition in the ration and mik production and its composition

Variables		Regression Line	Inflection Point (Y_m;X_o)
Production 3% FCM		$Y = 9.607 - 0.043x + 0.003x^2$	(9.45 ; 7.17)
DM	Morning	$Y = 14.317 - 2.735x + 0.301x^2$	(8.10 ; 4.54)
	Afternoon	$Y = 14.090 - 0.089x + 0.005X^2$	(13.69 ; 8.90)
NFDM	Morning	$Y = 8.813 - 0.038x + 0.002x^2$	(8.63 ; 9.50)
	Afternoon	$Y = 8.779 - 0.035x + 0.002x^2$	(8.63 ; 8.75)
Fat	Morning	$Y = 3.996 + 0.007x – 0.001x^2$	(4.01 ; 4.01)
	Afternoon	$Y = 5.243 - 0.034x + 0.002x^2$	(5.10 ; 8.50)
Protein	Morning	Y = 0.120 - 0.00008x - <<< ...	tt
	Afternoon	$Y = 0.129 - 0.00167x - 0.00009x^2$	(0.12 ; 9.53)
Lactose	Morning	$Y = 3.562 + 0.143x - 0.011x^2$	(4.03 ; 6.50)
	Afternoon	$Y = 3.968 + 0.027x - 0.003x^2$	(4.03 ; 4.50)
GI	Morning	$Y = 1.030 + 0.000025x - 0.000005x^2$	(1.03 ; -2.5)
	Afternoon	$Y = 1.029 - 0.000135x + 0.000005x^2$	(1.03 ; 13.5)

FCM = Fat Corrected Milk, DM= Dry Matter; NFDM = Non-fat Dry Matter; GI = Gravity Index; Y_m = maximum value of each response variable; X_o = optimum level of yeast addition; tt = not counted

secretory cells, whereas each cell had a maximum-size limit that determined the amount or magnitude of the maximum secretion rate (Walstra and Jennes, 1984; France and Thornley, 1984).

In addition, the rate of secretion was inhibited by the volume of accumulated milk in the udder. This phenomenon also occurred in the current experiments cows, shown by the noticable difference of the daily milk production among individual cows (P<0.01), and the difference among the trial periods (P<0.01), as shown in the following Table 2.

Analysis of variance on milk composition (Table 2) showed differences among trial animals (P<0.01), on Dry Matter (DM), Non-fat Dry Matter (NFDM) and milk fat. Trial period affected milk protein content (P<0.01), whereas the addition of yeast culture had no effect at all, except on NFDM levels at the afternoon; milking (P<0.01). In addition, other studies (Dann et al., 2000; Al-Ibrahim et al., 2010; Promkot et al., 2013) reported that the addition of *Saccharomyces cerevisiae* had no effect on milk production and composition in dairy cows. There was no consistency among results of the experimental from different dose use in the expermental, stage of lactation and animal age, composition feed and feeding strategy. This was due to the limits of the udder glands on each individual cow in uptaking nutrient from the blood, although the metabolites concentration in the blood increased (Suwandyastuti, 1986). However, this phenomenon did not apply to acetate. The increasable udder gland to uptake acetate was parallel to that of acetate concentration in the blood. Excluding fat, all components of the macro nutrients in milk for each individual cow were always steady, due to specific regulatory mechanisms in the udder gland (Walstra and Jennes, 1984; Suwandyastuti, 1986). However, it was most likely that the addition of yeast culture was not successful in increasing the concentration of precursor in the synthesis of milk fat in the blood. The high production of acetate in the rumen (66.72 ± 1.46 percent) did not increase concentration of acetate in the blood. Moreover, the addition of yeast culture also did not affect the total production of volatile fatty acids and acetate. As a result, the basic material for the synthesis of milk fat does not increase, so the milk fat content was also unchanged.

In udder, milk proteins were formed in two ways: (1) filtration process of blood amino acids and (2) partial oxidation of essential amino acids from the blood into the non-essential amino acids in milk protein (Oldham, 1981; Suwandyastuti, 1986). Amino acids from the *pudica externa* blood available for milk protein synthesis were also the same for all the trial rations. Both the morning and afternoon milking, milk protein content differed due to the effect of trial periods ($P<0.01$). Milk production and synthesis of milk components were the result of interaction between the availability of nutrients in the blood and hormonal factors (France and Thornley, 1984; Walstra and Jennes, 1984; Suwandyastuti et al., 1993). Changes in milk fat content between the trial periods were most likely caused by hormonal factors, as a result of changes in physiological condition of the trial animals. This was supported by the similarities of the pattern changes in protein content of milk in the morning and afternoon milking among all the trial periods.

In contrast to milk protein which is formed by two mechanisms, lactose and milk fat are formed through a synthesis process in the udder gland. Although the udder gland cells' ability to receive blood glucose is limited, blood glucose is the major precursor for the lactose synthesis. Blood glucose among others is derived from: (1) breakdown of liver glycogen and (2) the results of gluconeogenesis process. Because supply of ration glucose did notcontinue and the amount was so limited, the provision of blood glucose is always maintained and retained by the liver through various physiological biochemical processes (Campbell and Reece, 2005).

Both the provision of blood glucose in the liver and the synthesis of lactose in the udder gland always involve enzymes requiring magnesium as the activator. In this experiment, all trial diets contain only magnesium of 0.27 percent DM, whereas according to the results of the study of Suwandyastuti (1986) lactating dairy cows require magnesium as much as 0.586 ± 0.031 percent DM in order all metabolic processes to be optimimum. With the availability of basic materials and the amount of enzyme activators which tend to be similar, in addition to the regulation of specific synthesis mechanism in the udder glands, the milk lactose content was not affected by the addition of yeast culture in the diet, rather it is a natural biological phenomenon. The relationship between the level of addition of yeast culture and the milk production and its composition is presented in Table 3.

Conclusions

Based on all the observed and measured response variables, it can be concluded that (1) Production and composition of milk have not shown significant response to the addition of the yeast *Saccharomyces cerevisiae*, although as a whole it was still in a normal state, except for very low protein content (0.13%) and high fat content (4.50%); (2) Production and composition of milk reached maximum at the addition of the yeast *Saccharomyces cerevisiae* of 6.50 to 9.50 g/cow/day.

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