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Study of physic and organoleptic of butter developed using milk from cow and goat reared in Sleman Regency, Yogyakarta, Indonesia

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ABSTRAK

Kajian ini bertujuan untuk melihat sifat fisik-organoleptik mentega kambing dibandingkan dengan mentega sapi yang diternakan di lereng Gunung Merapi, Kabupaten Sleman, Daerah Istimewa Yogyakarta. Kedua jenis mentega telah dievaluasi ukuran dan jumlah butiran lemak, nilai kekerasan, titik leleh, nilai menyebar dan kinerja organoleptik. Ukuran dan jumlah lemak dikaji menggunakan mikroskop, kekerasan dengan penetromter, titik leleh mentega pada suhu yang beragam 30, 40, 50 ℃ dan titik penyebaran mentega dengan memberi beban 300 gram pada kubus mentega, Kinerja organoleptik dievaluasi oleh panelis. Hasilnya menunjukkan kedua jenis mentega tergolong baik. Mentega kambing memiliki butiran lemak ukuran kecil (<3μm) lebih banyak menunjukkan lebih lunak dengan nilai kekerasan kurang dari 0.3 kg/cm2 dibanding mentega sapi dengan nilai kekerasan lebih dari 1.0 kg/cm^2. Mentega kambing meleleh lebih cepat daripada mentega sapi dan menyebar kurang dari 1.5 menit dibanding mentega sapi yang membutuhkan waktu sebar 6 menit. Daya terima panelis terhadap mentega sapi lebih besar terhadap mentega kambing. Dapat disimpulkan, mentega sapi memiliki kinerja fisik yang lebih keras dan diterima lebih baik dari pada mentega kambing. Mentega kambing menunjukkan lebih baik dalam bentuk segar daripada disimpan.

Kata kunci : daya terima, mentega, ukuran lemak, kekerasan dan daya sebar, ternak perah tropis.

ABSTRACT

This study was to see physic-organoleptic of butter from goat as compared to cow butter reared in the Mt Merapi, Sleman regency, Yogyakarta. Both butter has been evaluated their fat size and numbers, the value of hardness, melting point, spreading and organoleptic performance. Fat size and numbers have evaluated microscopically, hardness by penetrometer, butter melting point at different temperature 30, 40, and 50 oC, as well as spreading by pressing down with ± 300 gram of weights. Organoleptic performances have been evaluated by panelist. The result of both butter were good. Goat butter contained more number of small-size fat globule lead to softer butter with hardness 0.3 kg/cm2 than cow butter with hardness more than 1.0 kg/cm2. Goat butter have melted faster than cow butter. Cow butter spreading were less rapid with 6 minutes than 1.5 minutes of goat butter. Panelist acceptance of cow butter were bigger than goat butter. It has been concluded that cow butter have had physically hard performance and well accepted than goat butter. Goat butter have presented well as fresh butter than storage butter.

Keywords: acceptability, butter, fat size, hardness and spreading, tropical dairy animals

INTRODUCTION

Livestock provides rural farmers with a way to increase assets, a method to diversify, and income and nutrition. Good nutrition and access to an adequate diet and health are essential for child growth and development, body maintenance and protection from both infectious and non-communicable diseases (NCDs) or community health in adult life. Food respond to human essential need and as life-basic print that can be allowed as way of life named *5 healthy - 6 halal principles*. Animal products therefore can be used to eradicate stunting which can be defined also as "under nutrition". Hunger, that if it happens in people, can lead to decrease physical and mental development, compromise immune system, as well as increase infectious disease. Animal provide protein foods, a complete food for human diet by supplying amino acids, fatty acids, minerals, vitamins and energy. Food from animal products, especially milk could be used to improve livelihood of farmers, children and mother in pregnant and lactation as well as vulnerable peoples in the world. To be well accepted by consumers of the era of 4.0 industrial revolution (4IR), farmers of small holder milk manufacturers should adopt added value strategy alongside of dairy business chains included presenting milk products that can be organoleptically accepted by consumers (Murti, 2019). Milk products can respond human diet need and improving their nutritional status and health (food safety). World milk production are still dominated by cow milk and limited availability in world milk market, that only < 10 % of world milk production, especially done by only 4 countries: European, India, Australia and New Zealand. World (and especially Indonesia) still ignore or not enough attention to care non bovine animals to produce more milk. Goat milk are considered as cow for poor people, which is less allergenic than cow milk and also have little risk to care it by women and children.

Milk and cream are examples of naturally occurring oil-in-water emulsions, in which the dispersed phase is fat in the form of membrane-covered globules and the continuous phase is milk plasma with its components (Nowak et al., 2017). While, Butter is water–in oil emulsion and become one of milk products that is well accepted by consumers to complete breakfast for most of western type of food. The size distribution of fat globules, native or subject to technological processes, is one of their main properties. It should be noted that an increase in the dimensions of fat globules can contribute to a change in the fatty acid content, which may have technological consequences. General method to develop butter has written by Walstra *et.al.* (2002). It is very useful for cow butter development but have some difficulty to develop goat butter which has more little size of fat globule. It is therefore to improve fat yield of goat butter it is needed to modify this method. Lee and Martini (2018) have considered that crystallization of milk fat in cream is essential for butter making to form a continuous fat network during churning. Similarly, crystallization of milk fat globules in cream is influenced by many factors such as cooling rate, aging time and temperature, churning temperature, and phase inversion that occurs during churning (Rønholt *et al.,* 2012). The size of milk fat globule of cream and/or dairy emulsion is also having impact on crystallization temperature, size and polymorph of crystals, solid fat content, stability and rheological properties (Hussain *et al.,* 2016; Truong *et al.,* 2014; Truong *et al.,* 2015). Before churning, cream is subjected to a program of cooling designed to control the crystallization of the fat so that the resultant butter has the right consistency. The consistency of butter is one of its most important quality-related characteristics, both directly and indirectly, since it affects the other characteristics - chiefly taste and aroma. Consistency is a complicated concept and involves properties such as hardness, viscosity, plasticity and spreading ability.

A traditional technique used to determine the sizes of fat globules is the microscopic method, based on their observation and measurement of their diameters. A microscopic observation provides comprehensive information concerning the dispersion of milk fat, as well as the occurrence and identification of certain types of emulsion instability, e.g. flocculation or disruption of fat globule membranes. Butter is a multiphase emulsion consisting of fat globules, crystalline fat and an aqueous phase dispersed in a continuous oil phase. Along with taste, as the consumers' point of view, the most important properties of butter are texture, appearance and spreading (Malvern, 2015). Hardness, is measured by penetrometer and spreading ability which is due to deformation or axial compression-decompression and normally measured by rheometer are inversely related to each other and are considered also as the two most commonly measured properties of butter. Penetrometer is the most widely used empirical method to determine the firmness or yield value of a plastic fat. The fat behaves like a rigid solid until the deforming stress exceeds the yield value and the fat starts flowing like a viscous liquid (de Mann and Beers, 1987). So by modifying the cooling program for the cream, it is possible to regulate the size of the crystals in the fat globules and in this way influence both the magnitude and the nature of the important continuous fat phase.

This study was to develop goat and cow butter using improved method of Walstra *et al.* (2000) by modify cooling time of cream and to characterize the value of hardness, melting profile, spreading value as well as flavor acceptance of entrained panelists on butter made from goat and cow milk reared in tropical condition, Sleman regency, Special province of Yogyakarta.

MATERIALS AND METHODS.

Materials

Raw material of cow milk was and mixed goat milk were obtained from smallholder farmer's group both at Turi and Pakem district the Sleman regency, Special Province of Yogyakarta, Indonesia (Figure 1). The regency of Sleman is located at the south slope of Mt Merapi (2900 m asl). It is riched in shrubs and vegetation as *Calliandra callothyrsus*, which is normally used as goat feeds. It is liked to plant due to fast growing, in which it's root nodulate with *Rhizobium* strains, while dairy cows, mainly Friesian Holstein fed using King grass. Goat

Figure 1. Maps of Research Location in Yogyakarta Province

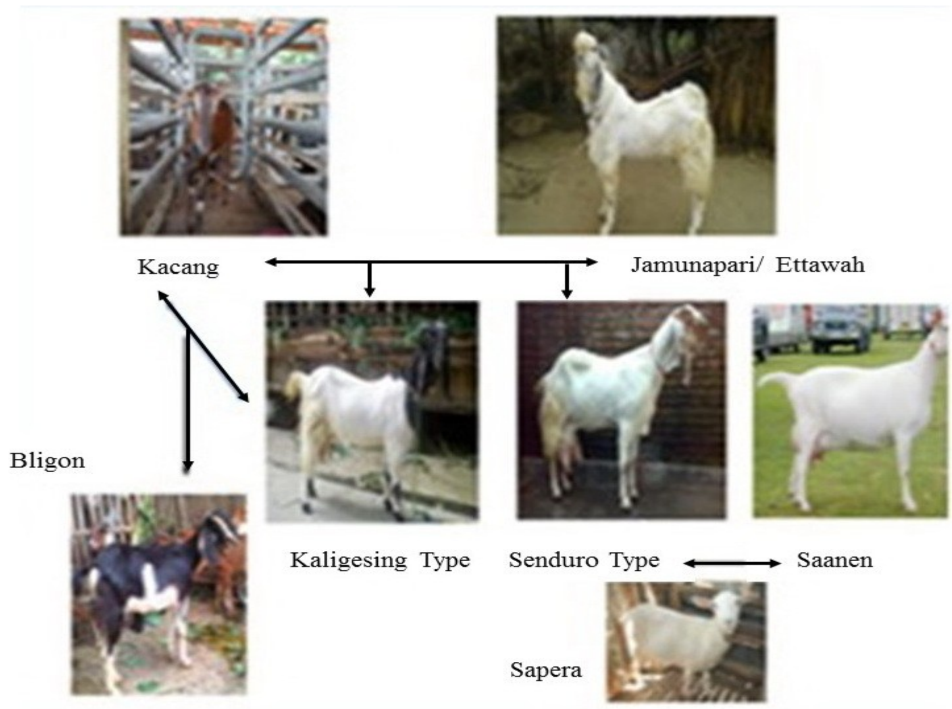


Figure 2. Dairy Goats in Sleman Regency

farmers reared some bred of dairy goat as presented in Figure 2.

Cream and Butter Manufacturing

Raw material of cow milk and goat milk were evaluated before butter manufacturing from 5 replication each from difference samples. Butter made from cream after separation of milk using cream separator (elecrem) and mixer (Fomac) as Walstra *et al.* (2002); Lee and Min (2014) in Figure 3. Both milk and cream were then analyzed microscopically their fat size and number/cm^2 using the method of Nowak *et al.* (2017) and Panchal *et al.* (2017) with different in magnification. While the percentage of fat in butter were detected by method of Sudarmadji *et al*. (1985). The microscopic method used is a set consisting of an optical microscope (Micconos), completed by microscope camera (Optilab)

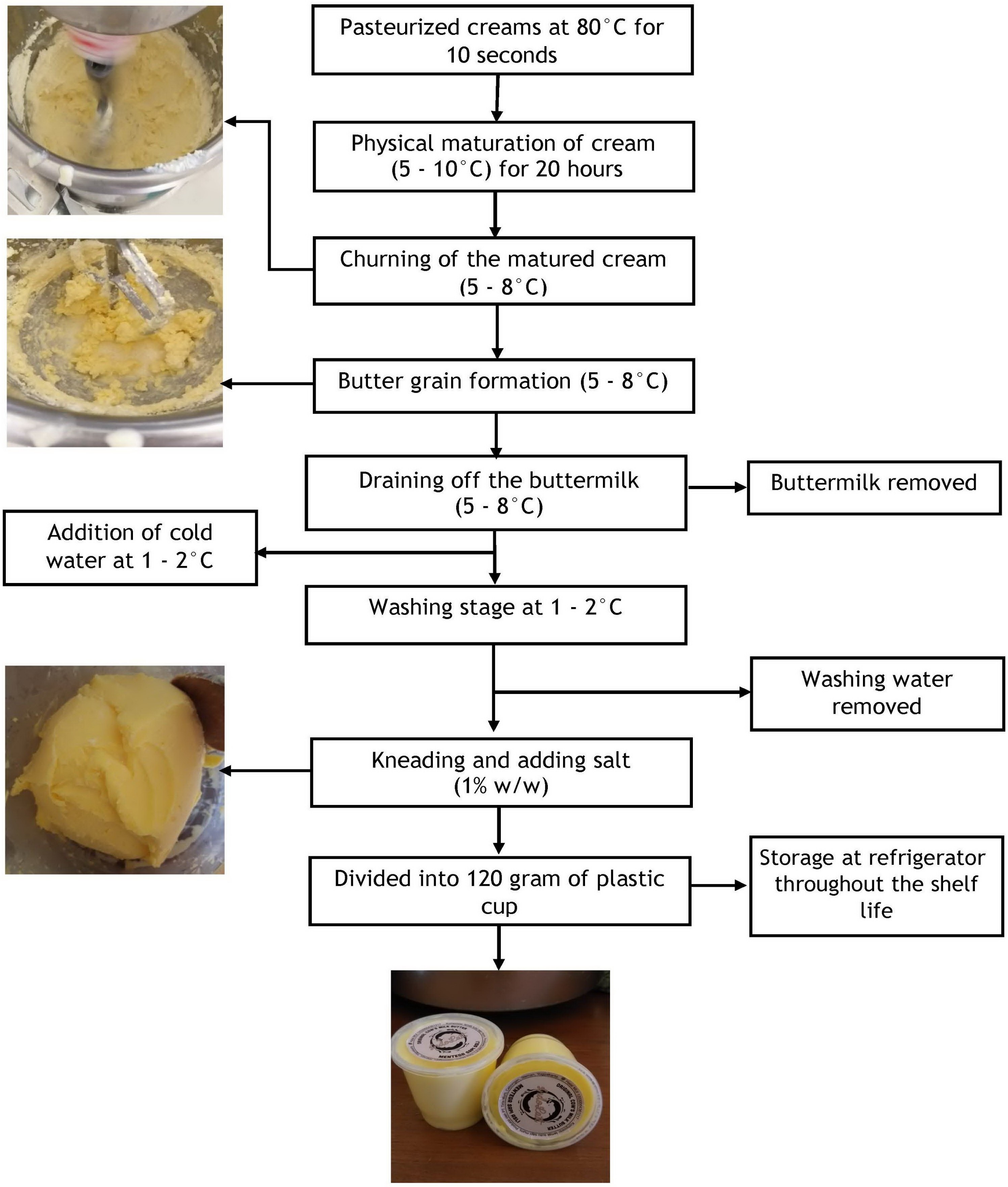


Figure 3. Flow Chart of Butter Manufacturing

(magnified 1000x), and a computer monitor. Fat globule diameters has been compared to the standard of scale using Image Raster application as Richter (2000) in which the percentage share of fat globules was calculated for specific size ranges, the mean diameter over surface area.

Analyze of Physical Performance of Butter

Butters hardness were calculated using the method of Deman and Beers (1987) in which Penetrometry is used to determine the firmness by regarding yield value after deformation by penetrometer. The value untill 200 g/cm^2 indicating butter is not spreadable. Pistolet fruit penetrometer GY1 (Digilife) was used in this experiment, 5 time for each measurement. Butters were kept in storage at refrigerator before measurement.

Butter melting point was detected using the method of Deman *et al.* (1983). One gram of butter have put into the glass tube than heated in a water bath at 30, 40 and 50°C, respectively then recorded the time in which the samples were melt completely.

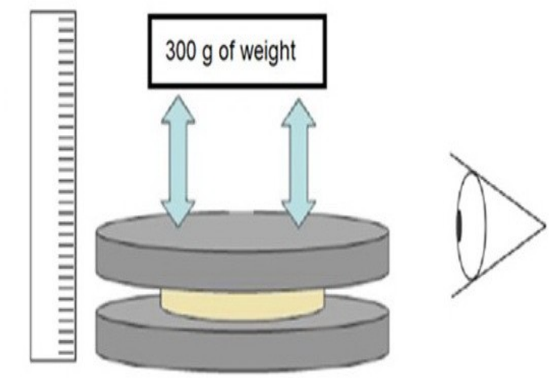


Figure 4. Schematic Measures of Butter Spreading

Butter spreading were analyzed using Malvern Pananalytical (2015). Butter cubical samples (2 x 2 x 2 cm^3) from each material were removed from storage at 5℃ and quickly placed between the two plates. Samples were pressed down with ± 300 gram of weights (estimated manual force for butter spreading) leading to deformation of butter, as in Figure 4. The time in which two plates narrowed down, monitored since the start to the stop as well as the distance between two plates.

Detection of Organoleptic Performance

Some entrained panelists have detected organoleptic performance of both butter using the method of Murti (2016). They have been entrained to understand the vocabulary and the standards of flavor. During the sample evaluation, panelists were instructed to spread the ± 5 grams of butter into piece of white bread (Krause *et al.,* 2007). It was used white bread "Borobudur" that was easily found in the market and well known by panelist. Panelist were asked to rate the spreading, after-odor, sandy, salty, and preference of butter using 4-point of hedonic scale, shown at the following Table 1, while salty standard according to Murti (2016).

RESULTS AND DISCUSSIONS

Result of the quality of raw materials of cow and goat milk were presented in Table 2. It has been tested that both raw milks were in normal quality. Negatives result of alcohol test for raw goat milk using 65% of alcohol, indicated good quality of goat milk. Normally, goat milk is precipitated at 45 until 68 % of alcohol, while for cow milk is at 70 % of alcohol (Guo *et al.,* 1998;

Table 1. Vocabulary Standard of Organoleptic Measures

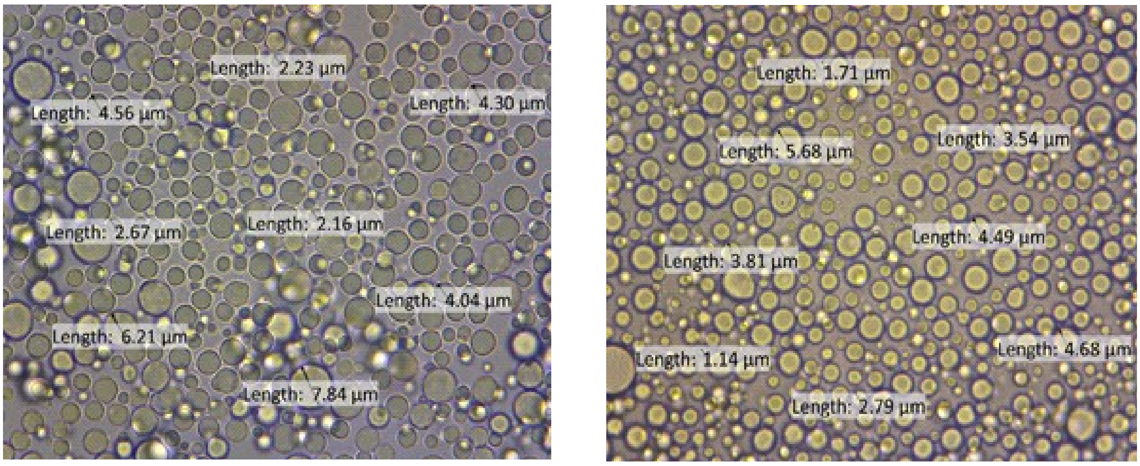
Score	Spreading	*After-odor**	Sandy*	Salty	Preference
1	Difficult	Weak	Rough	1.5 gram NaCl/L aquades	Dislike
2	Rather difficult	Quite strong	Quite smooth	3 gram NaCl/L aquades	Less-like
3	Easy	Strong	Smooth	4.5 gram NaCl/L aquades	Like
4	very easy	Very strong	Very smooth	6 gram NaCl/L aquades	Really-like

*Sandy = Perception in the final stages of mastication of thin rounded grains in the chewed mass; *After-odor = the odor that remains after being eaten; *Spreading = the compression stage corresponds with deformation and should be related to ease of spreading

Table 2. The Quality of Raw Material from Cow Milk and Goat Milk

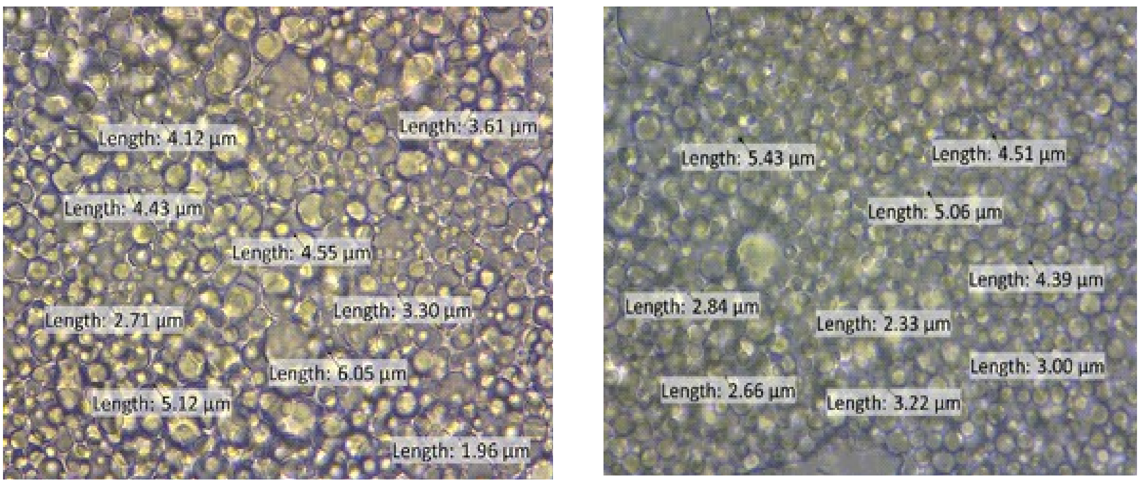
Parameter	Cow Milk	Goat Milk
Alcohol 70% test	Negative	NA
Alcohol 65% test	NA	Negative
Specific gravity	1.0285±0.00	1.0303±0.00
Fat (%)	3.95±0.21	5.35±0.21*
Humidity (%)	86.86±0.13	84,79±0.06*
Average fat size (µm)	3.52±1.15	3.08±1.07
Range of fat size (µm)	1.21 – 7.99	0.92 – 6.08

NA = not applied, *(P <0.05)



(a) (b)

Figure 5. Cow Milk Fat Globule (a) and Goat Milk Fat Globule (b) at magnified 1000 x



(a) (b)

Figure 6. Fat globule of cow cream (a) and goat cream (b) magnified 1000 x

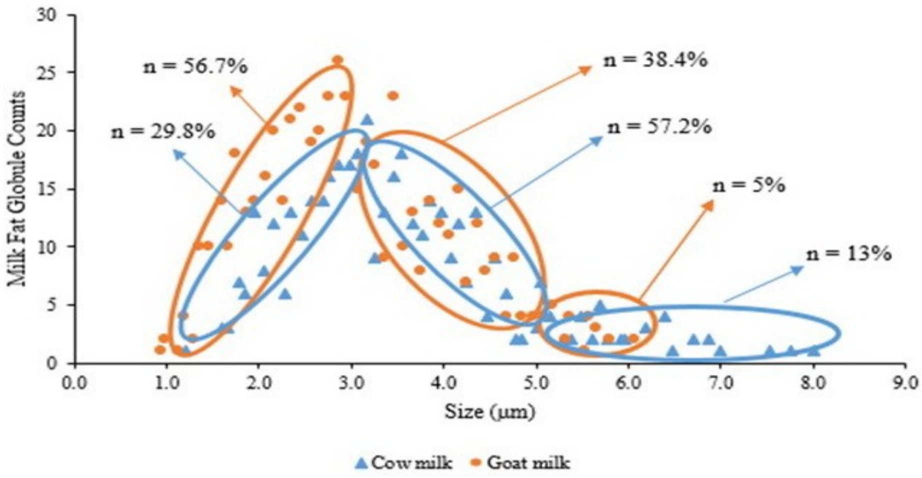


Figure 7. Scatter Representation of Fat Globules Sizes in Cow and Goat Milk

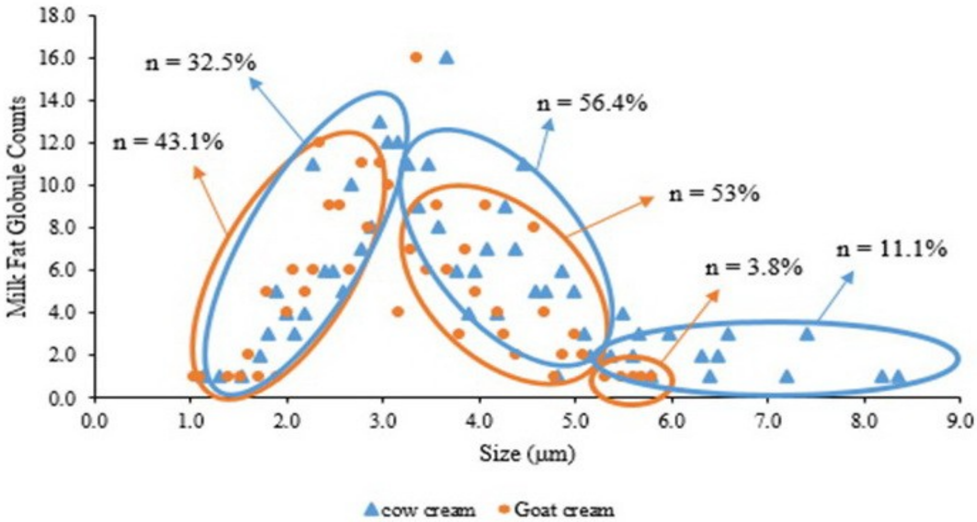


Figure 8. Scatter Representation of Fat globules Sizes in Cow and Goat Creams

Prajapati *et al*., 2017).

The number of fat globules in goat milk were counted more numbers than cow milk with 1400 and 1125 number of globules/0.6 mm lens objective field, respectively. It seemed that it is in relation to fat globules sizes. Goat milk has the average fat size more little and in lesser range than cow milk fat. Little size globules percentage have led to be softer than cow milk fat globules as well as in cream of both milk (Figures 5 and 6). It has been proved that detection of milk fat size and number can be done by optical microscopic as Nowak *et al.* 2017 and Panchal *et al.* 2017.

Goat milk fat have more small size of fat globules than cow fat globules in milk, with majority are less than 3 µm, while for cow milk fat globules between 3-5 µm in milk (Figure 7) also studied by Nowak *et al*., (2017).

There were agglomeration of certain numbers of smallest fat globules in goat milk during cream manufacturing, lead to majority between 3-5 µm of diameters of goat cream as well as cow cream (Figure 8). It has reduced the number of small size fat globule in milk by

24.6%.

Cow milk and cream have some number of fat with the diameters of 8 µm, while only until 6 µm for goat milk fat and cream (Murti, 2014, 2016; Nowak *et al.,* 2017; Attie and Richter, 2000; Barlowska *et al.,* 2011). The more the number of little size goat milk fat the easier making goat butter than cow butter. Karlović *et al.* (2014) said that lower diameter of fat globules affect the velocity of fat skimming which was faster. Despite it fat content of goat butter have not reached minimum percentage, 80% as standard minimum required as in Walstra *et al.* (2002). It was therefore a new method for improving the method of Walstra *et al.* (2002) by combining with the method of Lee and Min (2014) have increased fat yield of both butter to reach more minimum requirement, 80% of fat. Smaller fat globules <3.00 µm from goat milk also took less time to cold-churn using conventional low shear mixer churning method as compared to the more larger globules of cow fat milk. In this method, it was used 20 hours aging time longer than 90 min of aging time as presented by (Lee and Martini, 2018). This new method also has other advantage forming goat and cow butter less than 5 minutes churning time. Butter can be formed only from cream aged under certain conditions during 14.5 min of churning for cow butter which are 5°C with high agitation and 10°C regardless of agitation level (Lee and Martini, 2018).

It is rarely found study about hardness of goat butter. Yield value of hardness of goat butter

Table 3. Butter Hardness and Melting Time (s)

Butter Hardness (kg/cm^2)			Melting Time (s)		
Days	Cow butter	Goat butter	Temp.	Cow butter	Goat butter
0	ND[a]	ND[a]	30°C	Not melt	148,33±3,72
15	0,33±0,10	ND[a]	40°C	66,17±1,17*	46,67±0,82*
30	1,33±0,12*	0,27±0,10*	50°C	54,33±2,34*	14,83±1,17*

[a] Less than 0.2 (kg/cm^2), *($P<0.05$)

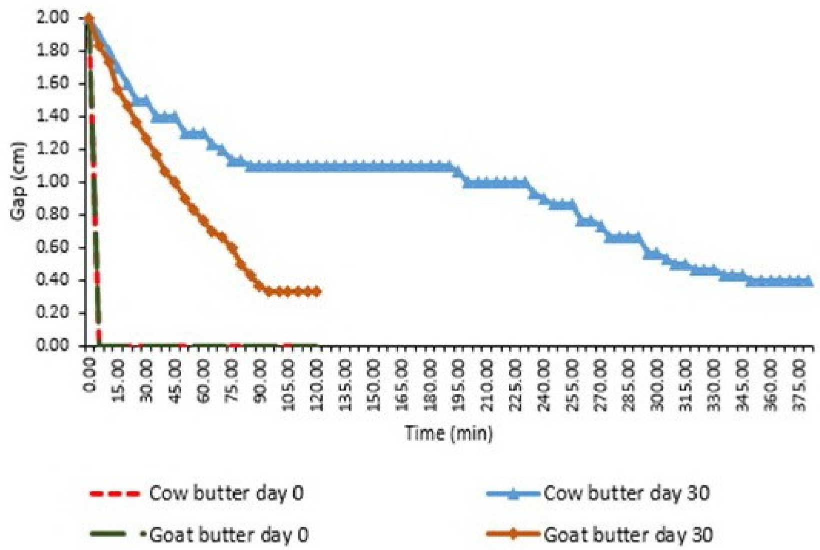


Figure 9. Cow Butter and Goat Butter Spreading

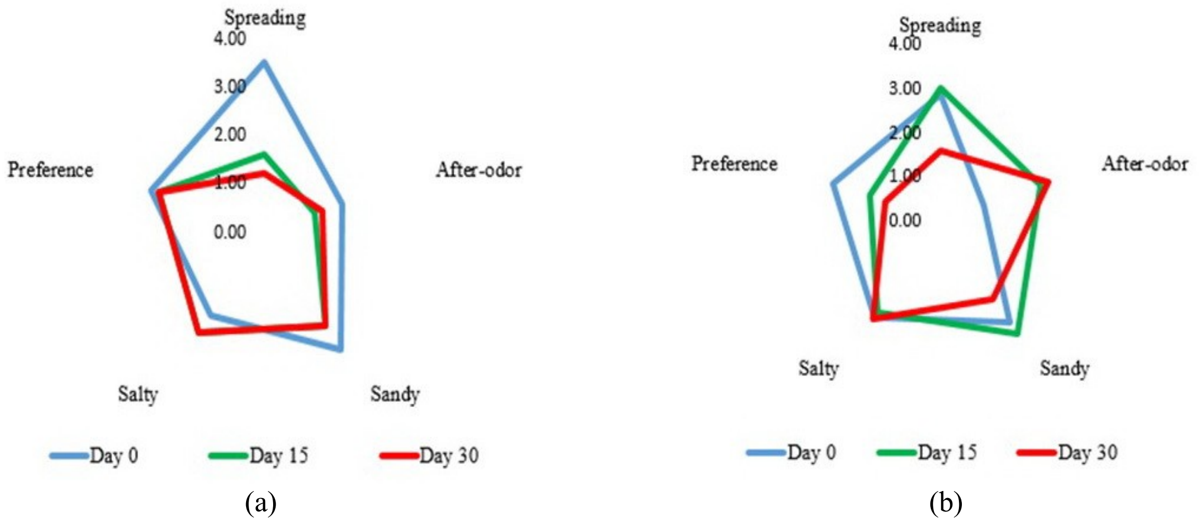


Figure 10. Pattern of Consumers Voices on Organoleptic Performance of Cow (a) and Goat (b) Butter

could be detected by new method after 30 days of storage. Before 30 days storage hardness of goat butter was less than 0.2 kg/cm^2 considered as soft, already spreadable. More number of small fat globule of goat cream can produce harder material as presented in Table 3, which were bigger and bigger after cold storage according to Lee and Martini (2018). While between 1.0-1.5 kg/cm^2 is considered as hard, limit of spreadable (Demans and Beers, 1987) as found in cow butter.

The melting point of goat butter was also more rapid than cow butter, even have been melting in room temperature 30^{o}C (Deman *et al.,* 1983). These results in Table 3 above has been strengthened by Figure 9, which have explained that cow butter spreading taken more time than goat butter spreading by more than 3 times. Cow butter was evaluated started to melt from 35^{o}C (Deman *et al.,* 1983). So, it has melted at 40^{o}C.

Fresh butters have spread less than 15 seconds, make it easy used. While, after storage 30 day, cow butter need 90s to be spread easily and after that it need an increase force. This indicates that the spreadable butter yields and deforms much more easily (it is less hard) as the case of goat butter than the normal cow butter considered as hard butter (Malvern, 2015). It may be new deformation happened after 180s.

The result of organoleptic test by entrained consumers indicated that at fresh condition goat butter has equivalent score of appreciation to cow butter. Despite cow butter have reduced its spreading value after 30 days of storage, it was still well accepted, while for goat butter they have reduced their acceptance even after 15 days in storage (Figure 10). Panelist considered that goat butter more sensed sandy led to less spreading value. It was assumed that the more the butter have fat globule bigger the less spreading and soft (Dhungana *et al.,* 2017).

CONCLUSION

It has been concluded that cow butter have had physically hard performance and well accepted than goat butter, due mainly to the size and the numbers of fat globules either fresh or at storage. Meanwhile, goat butter have presented and accepted well as fresh butter than storage butter. Despite it, regarding melting time and spreading values, in commercial usage as in café, or in restaurant, the more rapid they prepare a food, the more given satisfaction to consumers as physical character found in developed goat butter.

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