Animal Science Papers and Reports vol. 35 (2017) no. 2, 147-158
Institute of Genetics and Animal Breeding, Jastrzębiec, Poland

The effect of housing system of Simmental cows on processing suitability of milk and quality of dairy products

Iwona Radkowska*, Eugeniusz Herbut

National Research Institute of Animal Production, Department of Technology, Ecology and Economics of Animal Production, Krakowska 1, 32-083 Balice, Poland

(Accepted April 3, 2017)

The aim of the study was to determine the effect of two feeding systems (TMR – group I, pasture – group II) on physicochemical properties of milk, its suitability for making rennet cheese and butter, and sensory properties of these products. The study was conducted with second and third lactation Simmental cows between 30 and 200 days of lactation. Total milk yield for the lactation period was 6000 litres. Somatic cell count during the study was considerably higher in group I (350 thous·ml^{-1} on average) than in group II (250 thous.·ml^{-1} on average). During the study milk samples for chemical analyses were collected once a month. Milk of group II cows was characterised by lower active and potential acidity, higher ethanol stability, and greater tolerance to heat treatment. Rennet-induced clotting time was significantly ($p \leq 0.05$) shorter for milk of group II cows (202 sec) compared to that of group I cows (248 sec). Sensory evaluation showed that group II milk was characterised by better taste, more intense ($p \leq 0.05$) aroma, better consistency and significantly ($p \leq 0.05$) more intense yellow colour, which received a higher score. Rennet cheese yield per 10 l of milk was similar in both groups; however, cheese made from the pasture group milk had a more compact clot. The organoleptic evaluation showed that cheese from group II had a significantly ($p \leq 0.05$) more intense colour (4.73 *vs*. 4.07 pts), better consistency (4.87 *vs*. 4.00 pts) as well as better taste (4.87 *vs*. 4.20) and aroma (4.73 *vs*. 4.47) when compared to group I.

Immediately after production, butter made from milk of pasture-fed cows had considerably better fat parameters. Butter fat from group II was characterised by a higher iodine number, which measures fat unsaturation level. The higher unsaturated fatty acid content contributed to a decrease in solidification and melting points of fat and to more intense lipolytic and oxidative processes, as evidenced by the higher acid number, peroxide value and TBA value. At the beginning of storage, butter produced

*Corresponding author: iwona.radkowska@izoo.krakow.pl

from milk of group II cows received significantly (p≤0.05) higher scores for colour and consistency as well as higher (p≤0.05) scores for aroma and taste. At 30 days of storage no differences were observed between the groups. The results of the present experiment show that pasture feeding has a positive effect on the processing suitability, of milk and the sensory properties of rennet cheese and butter, but the produced butter is more susceptible to undesirable changes during storage.

KEY WORDS: quality milk products / milk / processing suitability / Simmental cows

In most European countries, including Poland, where grazing was reduced or abandoned due to substantial increases in milk yield and the increasingly widespread use of TMR, we may currently observe renewed interest in pasture feeding of cows. Increased awareness of the impact of diet on human health and the growing number of consumers concerned about product quality and animal welfare conditions have encouraged manufacturers to produce high-quality food in an environmentally-friendly manner [Sikiric *et al*. 2003]. A growing interest in functional foods promotes the introduction of such products into the market; for example, a study by Saulais and Ruffieux [2012] demonstrated that consumers are willing to pay more for butter of high nutritional value. Due to its nutritional properties, milk may be considered a multifunctional food product [Descalzo *et al*. 2012]. It is a source of proteins, lipids, vitamins, minerals and biologically active substances, which have a beneficial effect on the human body [Guimont *et al*. 1997, Strzałkowska *et al*. 2009b, Jóźwik *et al*. 2010, Strzałkowska *et al*. 2010]. Nutrients from the pasture positively affect digestion and health of grazing animals and they are also transferred into milk. A special role, from the human health point of view, is attributed to functional fatty acids, such as omega-3 and conjugated linoleic acid (CLA), found in considerable amounts in pasture herbage [Čermák *et al*. 2013]. The type of ruminant feed has a substantial effect on the composition and sensory properties of milk [Strzałkowska *et al*. 2009a]. Research shows that milk obtained from pasture-fed cows differs from that of conventionally fed cows in terms of taste, texture and colour, which has a considerable effect on the quality and taste of the resulting dairy products [Couvreur *et al*. 2006]. Most milk in the world is consumed processed, and a wide range of milk products is obtained using various technological processes. People mainly consume milk fat in different forms of traditional dairy products, such as liquid milk, butter, cream, cheese and ice cream [Strzałkowska *et al*. 2014]. The technological suitability of milk, especially for cheese making, is determined by the content of milk solids-not-fat, milk acidity, and enzymatic coagulation properties [Barłowska *et al*. 2006]. Total protein and casein contents are also very important parameters of cow's milk composition. Higher levels of these components result in superior processing properties of milk, as it is more useful for cheese-making [Felenczak *et al*. 2006].

Therefore, the aim of the study was to determine the effect of housing system of Simmental dairy cows on physicochemical properties of milk, the yield and quality of the resulting rennet cheese and butter.

Material and methods

The experiment was performed on Simmental dairy cows at the Experimental Station of the National Research Institute of Animal Production Odrzechowa Ltd.. Second and third lactation Simmental dairy cows between 30 and 200 days in milk were used in the experiment. Mean total milk yield for lactation period was 6 000 liters. Mean somatic cell count during the study was considerably higher in group I (350 thous$\cdot$ml^{-1} on average) than in group II (250 thous.$\cdot$ml^{-1} on average).

The experimental cows were allocated to two groups – barn-housed cows fed TMR (group I) and pasture-fed cows (group II).

Each experimental group consisted of approximately 50 cows. The observations were recorded from May to October. Cows from group I were fed TMR, which contained 25 kg maize silage, 8 kg haylage, 8 kg fresh brewers' grains, 4.5 kg ensiled maize grain, 2 kg rapeseed cake, 1.2 kg soybean meal (48% CP), 0.5 kg meadow hay, 0.5 kg straw and mineral supplements. The nutritive value of TMR (1 kg DM) was 0.86 UFL, 0.86 LFU, 91 g PDIE and 100 g PDIN. Depending on the vegetation season, group II cows consumed between 45 and 55 kg of forage per day, and additionally received concentrate (3 kg), maize silage (10 kg), and brewer's grains (2 kg).

The nutritive value of the ration was 0.96 UFL, 0.90 LFU, 97 g PDIE and 109 g PDIN. The animals were under strip grazing management. During the vegetation period the botanical composition of the sward was evaluated prior to each grazing. The largest group were grasses (almost 80%), which consisted predominantly of perennial ryegrass (*Lolium perenne* L.), red fescue (*Festuca rubra* L.) and meadow bluegrass (*Poa pratensis* L.). On average legumes constituted 11% and dicotyledons 9% of the sward.

During the study milk samples for chemical analyses were collected once a month. The following milk parameters were measured to determine the processing suitability of raw milk: density (using a lactometer), titratable acidity (titrimetric method), pH (using a CP-411 laboratory pH meter, Elmetron, Poland, equipped with an ERH-111 electrode, Hydromet, Poland), rennet-induced clotting time (Schern method), ethanol stability, freezing point (using a SEMIC® cryoscope, Bioelektronika, Poland) and heat stability (according to White and Davies 1966).

Immediately after transportation, milk intended for production was heated to 45°C and centrifuged with a skimming centrifuge. To obtain butter, cream obtained by centrifugation was pasteurized at 95°C for 90 sec and immediately chilled to 10°C. Next, cream was subjected to 24-hour physical maturation at 7°C. Thus prepared cream was churned in a batch-type churn for 45-60 minutes until the grains were the size of 2-3 mm . Buttermilk was separated, butter grains were rinsed 3 times with water at 11°C and kneaded until no more water droplets appeared on butter surface. Formed batches of butter weighing approximately 100 g were packed in aluminium foil and stored at 4°C until analyses. Butter analyses were performed after 1, 15 and 30 days of storage and included detailed evaluation of butterfat quality: acid number, peroxide value, TBA value, iodine number, fat melting point and fat solidification point. Butter was also subjected to basic composition analysis and sensory evaluation.

To produce rennet cheese defatted milk was pasteurized at 75°C for 15 sec and immediately chilled to milk rennet coagulation temperature of 32°C. Chilled milk was supplemented with 0.02% calcium chloride ($CaCl_2$) and FL-DAN lyophilized culture (Chr. Hansen). Thirty minutes after adding the culture milk was renneted with Fromase 2200 TL (DSM France) added in the amount required to form a clot after 45 minutes at 32°C. A 1:1000 rennet solution was used. The coagulum was cut into approx. 6 mm grains and the mass was mixed for 10 min. Next whey was drained, water was added at 32°C in the amount equivalent to that of whey drained and the granules were dried for 5 min. The mass was heated to 38°C at 1°C/2 min and dried for 20 min. The dried grains were allowed to settle and the mass was moved to perforated stainless steel moulds. After 24 h cheese was subjected to physicochemical analyses and organoleptic evaluation. The following cheese components were analysed: solids by the oven drying method, total protein content by the Kjeldahl method, fat content by the gravimetric method, ash content by the gravimetric method according to AOAC 935.42:1995 and carbohydrate content by calculating.

The sensory evaluation of the milk products was conducted using a 5-point scale (5 – excellent, 4 – very good, 3 – good, 2 – poor, l – very poor) under conditions conforming to the requirements of the PN-ISO 6658 standard (1998) by a 5-member expert panel. This evaluation comprised the following quality attributes and the corresponding weighting factors:

– for raw milk: appearance and colour – 0.15, consistency – 0.10, aroma – 0.35, taste – 0.40;

– for butter: appearance and colour – 0.15, consistency – 0.25, aroma – 0.25, taste – 0.35;

– for rennet cheese: colour – 0.15, consistency – 0.25, aroma – 0.25, taste – 0.35.

The weighting factors for each product quality attribute were used to calculate overall sensory quality. The overall score was defined as the score obtained by dividing the sum of points awarded to a given product (the product of scores awarded to each attribute times their weighting factors by the sum of weighting factors.

The differences between group means were examined by ANOVA and Duncan's test using Statistica 12 (StatSoft, Polska 2013).

Results and discussion

The analyses showed that milk from pasture-fed cows, especially in regions of high natural value with a large proportion of meadows, has high processing quality [Barłowska and Litwińczuk 2006]. In our study milk density was similar in both groups and averaged 1.030 g·ml^{-1} in group I and 1.029 g·ml^{-1} in group II (Tab. 1), thus falling within the normal range specified by the Polish Milk Standard PN-A-86002:1999 (not smaller than 1.028 g·mL^{-1}), pH value was at a satisfactory level in both groups and conformed to the Polish standards, whereas potential acidity (SH°) in group I slightly exceeded the acceptable range at 7.5°SH value (PN-A-86002:1999). Milk from group II was characterised by lower active and potential acidity, higher ethanol stability and greater resistance to heat treatment. One of the most important parameters determining milk suitability for cheese making is rennet-induced clotting time. In our study it was 248 sec for milk from group I in comparison to 202 sec for milk from group II, which is significantly ($p \leq 0.05$) shorter (Tab. 1). According to Devold *et al.* [2000], feeding system has a significant impact on protein (casein, whey proteins) content and mineral contents (calcium, magnesium, citric acid) in milk, which in turn have a significant effect on milk coagulation time. The significantly ($p \leq 0.05$) shorter (by 46 sec) rennet-induced clotting time, which was observed for milk from pastured cows, is consistent with the results of Tyrisevä *et al.* [2003], who found milk from cows fed pasture forage to coagulate more quickly after the addition of the clotting enzyme. Likewise, Barłowska and Litwińczuk [2006] showed a significantly ($p \leq 0.01$) shorter clotting time for milk of pasture-fed Whiteback and Simmental cows (5.18 and 5.43 min on average) when compared to that of Black-and-White cows (7.06 min) kept indoors. De Marchi *et al.* [2007] reported a shorter milk clotting time during summer months. A shorter clotting time was also observed to be related to lower milk pH [Remeuf *et al.* 1991].

Table 1. Averages and standard deviations of physical properties, indicators of processing suitability and sensory evaluation of milk

Parameter	Group I	Group II	SEM
Density ($g \cdot cm^{-3}$)	1.030	1.029	0.195
Freezing point (^oC)	-0.550	-0.550	0.156
Titratable acidity (°SH)	7.53	7.40	2.98
pH	6.75	6.73	0.61
Rennet-induced clotting time (sec.)	248.7^b	202.4^a	19.4
Heat stability at 140°C (sec.)	240.7	250.1	8.4
Ethanol stability [cm^3 96% C_2H_5OH]	2.27^a	3.16^b	24.30
Protein-to-fat ratio	0.85	0.85	3.29
Sensory score (points)			
colour	4.20^a	4.84^b	11.17
consistency	4.52	4.60	11.00
aroma	4.32^a	4.84^b	10.89
taste	4.72	4.92	8.05

^{ab}Within rows means bearing different duperscripts differ significantly at$p \leq 0.05$.
Group I – barn-housed cows fed TMR; Group II – pasture-fed cows.

Milk clotting properties are an important factor influencing cheese yield and quality. In many countries milk production has increased with advances in cattle breeding; however, milk clotting properties have decreased and the population of cows producing non-clotting milk has increased [Tyriseva *et al.* 2003]. Heat stability of milk is another important indicator of its suitability for heat treatment. It shows the ability of milk proteins to withstand severe heat treatment without visible coagulation or gelation. Litwińczuk *et al*. [2006] reported thatincreased acidity is the main reason for reduced heat stability of milk. This relationship was confirmed in our study for group I, where higher potential and active acidity and lower heat stability were observed. Analyses also showed that the low level of heat stability may be associated with high contents of whey proteins and low contents of casein protein [O'Connell and Fox, 2000; Polák *et al*. 2011]. Furthermore, heat stability of milk may also be influenced by the housing system and the production season [Williams 2002].

Milk suitability for cheese making is also determined by the protein to fat ratio. In both experimental groups this ratio was favourable and averaged 0.85. The results obtained are in agreement with the study of Litwińczuk *et al*. [2014], who showed that the Simmental breed has a genetically determined beneficial protein to fat ratio in milk. A significantly higher protein to fat ratio in Simmental milk was also reported by Barłowska *et al*. [2006] and Litwińczuk *et al*. [2014].

Consumers are becoming increasingly aware of sensory attributes of milk, butter and cheese, such as taste, colour and consistency. Consumers are also becoming more interested in products from dairy cows grazed on natural, botanically rich pastures compared to cows fed conserved feeds [Kalač 2011]. The sensory assessment showed that milk from both groups had typical taste, aroma, colour and consistency. However, milk from group II had better taste attributes, a more intense aroma ($p \leq 0.05$), better consistency and significantly ($p \leq 0.05$) more intense yellow colour, which received a higher score (Tab. 1). Pasture sward is a valuable source of carotenes that have strong antioxidant properties; β-carotene finds its way into milk from blood via the mammary gland and influences the yellow colour of both fat and milk products [Martin *et al*. 2005]. The uniquely creamy colour of milk and the yellow colour of butter and cheese are positively perceived by many consumers as indicating the natural feeding of cows. Carotenoids are fairly stable in plant cells, but suffer considerable losses during preservation of feeds. β-carotene content averages 196 mg in green forage, 159 mg in dried forage, 81 mg in silage and only 36 $mg \cdot kg^{-1}$ d.m. in hay [Williams *et al.* 1998]. Research shows that the carotenoid contents of feed and milk and thus different milk colour may be modified by the diet. Studies conducted in France by Agabriel *et al*. [2007] demonstrated that milk had the most intense yellow colour in September and the least intense colour in February. Similar results were obtained by Ellis *et al.* [2007], who found the lowest β-carotene level in milk during the winter feeding period. Our results confirm that milk from pasture-fed cows (group II) had a more intense ($p \leq 0.05$) yellow colour compared to that of group I cows fed based on conserved feeds (TMR).

Rennet cheese yield per 10 l of milk was similar in both groups (1.10 kg in group I, 1.12 kg in group II), but cheese made from the pasture group milk had a more compact curd. During rennet-induced coagulation the curd formed by coagulation of milk from group I was markedly more loose, which made the curd more difficult to process and dry, while cheese had a higher water content. The solids content in 100 g rennet cheese made from milk of pasture-fed cows was 13% higher ($p \leq 0.05$) at 30.31 g (Tab.

Table 2. Basic chemical composition and organoleptic evaluation of rennet cheese

Parameter	Group I	Group II	SEM
Basic chemical composition (g·100 g^{-1} rennet cheese)			
solids	26.83^{a}	30.31^{b}	6.71
protein	19.97^{a}	22.37^{b}	6.39
fat	0.44	0.46	19.06
total carbohydrates	3.98^{a}	5.04^{b}	13.36
ash	2.26^{a}	2.51^{b}	11.83
Sensory score (points)			
colour	4.07^{a}	4.73^{b}	11.32
consistency	4.00^{a}	4.87^{b}	11.37
aroma	4.47^{a}	4.73^{b}	10.83
taste	4.20^{a}	4.87^{b}	11.19

[ab]Within rows means bearing different superscripts differ significantly at $p \leq 0.05$.
Group I – barn-housed cows fed TMR; group II – pasture-fed cows.

2). This cheese contained significantly ($p \leq 0.05$) more protein and carbohydrates. The organoleptic evaluation showed that cheese from group II had a significantly ($p \leq 0.05$) more intense colour (4.73 *vs*. 4.07 pts), better consistency (4.87 *vs.* 4.00 pts) as well as better taste (4.87 *vs*. 4.20) and aroma (4.73 *vs*. 4.47) when compared to that from group I. Milk processing quality has an effect on the physicochemical properties and sensory attributes and on the yield of curd cheese [Fekadu *et al*. 2005]. Studies conducted on different types of cheese show that type of feed (conservation method, botanical composition) has a significant effect on cheese properties, including its texture [Verdier-Metz *et al*. 2000]. The concentration of carotenoids in pasture sward changes during the vegetation season, which has an effect on the colour of milk and cheese produced [Nozičre *et al.* 2006]. Carpino *et al*. [2004a] showed that cheeses produced from milk of cows consuming native pasture plants had a higher yellowness index compared to cheeses from TMR fed cows, which resulted from the carotenoid content. A similar study by Coppa *et al.* [2011] demonstrated that cheeses made from milk of cows fed a hay-based diet were less creamy, less elastic and less yellow than cheeses made from the milk of pasture-fed cows. Aroma substances, complex terpenoids, ketones and aldehydes may pass from the diet or the rumen into milk and cheese, lending them a characteristic aroma. Dicotyledonous species, which are often regarded as weeds on pastures, were found to influence the taste of cheese. Carpino *et al*. [2004b] showed that unique aromas of compounds found in the plants may be transferred into cheeses. Ragusano cheese produced from milk of pasture-fed cows was identified to contain 27 odour-active compounds, while only 13 were found in cheese made from the milk of TMR-fed cows. These cheeses were much richer in active aldehydes, esters and terpenoid compounds. Studies on Simmental cows showed that milk and cheese from pasture- compared to hay-fed cows had higher fat and protein contents. The rearing system also affected cheese colour as well as texture parameters, hardness, gumminess and chewiness, which were higher in cheese from pasture-fed cows [Romanzin *et al.* 2013].

Fat and water contents are the main determinant of butter quality. Butter made from milk of group I and II cows had similar fat contents (85.5 and 85%, respectively). Butter from group I cows had a significantly ($p \leq 0.05$) lower water content and higher ($p \leq 0.05$) solids-not-fat content (Tab. 3). These results are in agreement with those reported by Tambor *et al.* [2015], who showed traditional butters to contain

Table 3. Basic composition of butter

Parameter	Group I	Group II	SEM
($g \cdot 100\ g^{-1}$ butter)			
Fat content	85.51	85.03	0.33
Water content	12.42^{a}	13.63^{b}	4.98
Solids-not-fat content	1.51^{b}	1.23^{a}	11.93

^{ab}Within rows means bearing different superscripts differ significantly at $p \leq 0.05$.
Group I – barn-housed cows fed TMR; group II – pasture-fed cows.

Table 4. Selected butter fat parameters and sensory evaluation of butter at 1, 15 and 30 days of storage

Parameter	Group I			Group II			SEM
	1	15	30	1	15	30	
Acid number ($mg \cdot KOH \cdot g^{-1}$ fat)	1.099^{a}	1.233^{b}	1.456^{c}	1.283^{b}	1.411^{c}	1.644^{d}	13.685
Peroxide number (meq active oxygen$\cdot kg^{-1}$ fat)	0.180^{a}	0.289^{ab}	0.350^{b}	0.232^{a}	0.360^{b}	0.428^{c}	30.226
TBA (absorbance at 532 nm)	0.133^{a}	0.244^{ab}	0.267^{c}	0.214^{b}	0.308^{c}	0.408^{d}	34.911
Iodine number ($g \cdot 100\ g^{-1}$ fat)	27.02	26.56	26.41	28.15	27.78	27.49	2.84
Melting point (°C)	38.45	38.44	38.58	37.48	37.50	37.73	1.61
Solidification point (°C)	20.59	20.54	20.66	20.02	20.06	20.21	1.61
Sensory traits (points)							
colour	4.07^{a}	4.00^{a}	4.00^{a}	4.87^{b}	4.00^{a}	4.00^{a}	8.77
consistency	4.07^{a}	4.00^{a}	4.00^{a}	4.73^{b}	5.00^{c}	4.00^{a}	10.72
aroma	4.40^{b}	4.67^{c}	4.00^{a}	4.93^{d}	4.00^{a}	4.00^{a}	10.94
taste	4.53^{b}	5.00^{c}	4.00^{a}	4.93^{c}	4.67^{b}	4.00^{a}	11.11

^{ab}Within rows means bearing different superscripts differ significantly at $p \leq 0.05$.
Group I – barn-housed cows fed TMR; group II – pasture-fed cows.

significantly less solids-not-fat. Selected butterfat parameters were evaluated after 1, 15 and 30 days of storage (Tab. 4). Free fatty acid contents and acid number are indicators of lipolytic changes, whereas peroxide value and TBA reflect oxidative changes in butter. The acid number of fat increased during butter storage. In all the analysed storage periods a higher acid number was characteristic of butterfat from milk of group II cows. The acidity results conform to those of Tambor *et al.* [2015], who found significantly higher acidity in the group of traditional butters.

Adahchour *et al.* [2005] attributed the higher acidity of traditional butters to more intensive biological maturation, during which organic acids (including acetic acid) are formed as a result of microbial activity. The maximum permissible peroxide and TBA values in butterfat are 0.3 [meq oxygen·kg^{-1} fat] and 0.3 [absorbance at 532 nm], respectively (Commission Regulation (EC) No. 273/2008). The peroxide value was slightly exceeded for butter from milk of group II cows after 15 days of storage (0.36 meq oxygen·kg^{-1} fat), and as late as after 30 days of storage for butter from milk of group I cows (0.35 meq oxygen·kg^{-1} fat). It is accepted that oxidative rancid flavour is perceptible when peroxide value exceeds 1. An above normal increase in TBA was only found for butter from milk of group II cows after 15 days of storage. An important quality criterion of milk fat is the proportion of unsaturated fatty acids (UFA) expressed as iodine number, which measures fat unsaturation level. Butter made from milk of group II cows was characterised by a non-significantly higher iodine number at every stage of storage. Fats higher in UFA are more susceptible to autoxidation [Gonzalez *et al*. 2010]. Pasture feeding contributes to an increase in the oleic acid content, thus increasing the iodine number of fat. The melting and solidification points of butter are associated directly with UFA contents [Lipiński *et al.* 2012]. The unsaturation index of milk fat is the main determinant of its nutritive and health-promoting value as well as butter consistency. The melting and solidification points of fat are reflected in changes in fat consistency depending on temperature, and their values determine butter spreadability. In our study the melting and solidification points of butterfat from milk of group II cows were slightly lower at every stage of storage, although the differences were non-significant. Excessively hard consistency of butter during the winter feeding period of cows is caused, among other things, by the low UFA content. Couvreur *et al*. [2006] reported that increasing the proportion of fresh grass in the diet of cows caused a linear increase in the milk UFA content, which reduced the melting point of butter and had a positive effect on the spreadability index of butter.

The organoleptic evaluation of fresh butter showed that at the beginning of storage butter produced from milk of group II cows was characterised by better parameters. It received significantly ($p \leq 0.05$) higher scores for colour and consistency as well as higher ($p \leq 0.05$) scores for aroma and taste. After 15 days of storageits consistency improved ($p \leq 0.05$), while aroma and taste scores were significantly ($p \leq 0.05$) lower compared to butter from milk of group I cows. At 30 days of storage no differences were observed between the groups. Milk products from milk of cows receiving feeds rich in polyunsaturated fatty acids are more abundant in health-promoting fatty acids and softer, while they are particularly susceptible to oxidation, which shortens their shelf life and changes their taste and aroma [Chen *et al.* 2004]. The evaluation of sensory quality of conventional and traditional butters by Tambor *et al.* [2015] showed significantly higher “buttery taste” intensity in the group of traditional butters. The characteristic buttery taste of butter results from the production technology, in particular from the biological acidification of cream, which gives rise to bacterial metabolism products, including diacetyl from citrate metabolism, as well as butyric and lactic acids. They lend the characteristic taste and aroma to butter [Mallia *et al.* 2007].

In conclusion, feeding of cows has a considerable impact on the quality of milk and dairyproducts. The results of this study confirmed that pasture feeding of Simmental cows has a positive effect on processing suitability of milk and sensory attributes of produced rennet cheese and butter. Butter made from milk of pasture-fed cows had considerably better parameters immediately after production, but it was more susceptible to undesirable changes in fat parameters during storage.

REFERENCES

1. ADAHCHOUR M., WIEWEL J., VERDEL R., VREULS R.J.J., BRINKMAN U.A.T., 2005 – Improved determination of flavour compounds in butter by solid-phase (micro)extraction and comprehensive two-dimensional gas chromatography. ***Journal of Chromatography A*** 1086, 99-106.
2. AGABRIEL, C., CORNU, A., JOURNAL, C., SIBRA, C., GROLIER, P., MARTIN, B., 2007 – Tanker milk variability according to farm feeding practices: Vitamins A and E, carotenoids, color and terpenoids. ***Journal of Dairy Science*** 90, 4884-4896.
3. AOAC Official Method 935.42 (1995). Ash of cheese Official methods of analysis of AOAC International. Gaithersburg, MD: AOAC International. (16th ed.) II, 59.
4. BARŁOWSKA J., LITWIŃCZUK Z., 2006 – Technological usefulness of milk from two local breeds maintained in the regions with great grassland share. ***Archiv fűr Tierzucht*** 49: 207-213.
5. BARŁOWSKA J., LITWIŃCZUK Z., KRÓL J., TOPYŁA B., 2006 – Technological usefulness of milk cows of six breeds maintained in Poland relative to lactation phase. ***Polish Journal of Food and Nutrition Sciences*** 15/56, (1), 17-21.
6. CARPINO S., HORNE J., MELILLI C., LICITRA G., BARBANO D.M., VAN SOEST P.J., 2004a – Contribution of native pasture to the sensory properties of Ragusano cheese. ***Journal of Dairy Science*** 87, 308-315.
7. CARPINO S., MALLIA S., LA TERRA S., MELILLI C., LICITRA G., ACREE T., 2004b – Composition and Aroma Compounds of Ragusano Cheese: Native Pasture and Total Mixed Rations. ***Journal of Dairy Science*** 87, 816-830.
8. ČERMÁK B., KRÁL V., FRELICH J., BOHÁČOVÁ L., VONDRÁŠKOVÁ B., ŠPIČKA J., SAMKOVÁ E., PODSEDNÍČEK M., WĘGLARZ A., MAKULSKA J., ZAPLETAL P., 2013 – Quality of goat pasture in less-favoured areas (LFA) of the Czech Republic and its effect on fatty acid content of goat milk and cheese. ***Animal Science Papers and Reports*** 31, 331-346.
9. CHEN S., BOBE G., ZIMMERMAN S., HAMMOND E.G., LUHMAN C.M., BOYLSTON T.D., 2004 – Physical and sensory properties of dairy products from cows with various milk fatty acid compositions. ***Journal of Agricultural and Food Chemistry*** 52, 3422-3452.
10. Commission Regulation (EC) No. 273/2008 of 5 March 2008 laying down detailed rules for the application of Council Regulation (EC) No 1255/1999 as regards methods for the analysis and quality evaluation of milk and milk products.
11. COPPA M., FERLAY A MONSALLIER F., VERDIER-METZ I., PRADEL P., DIDIENNE R., FARRUGGIA A., MONTEL M.C., MARTIN B., 2011 – Milk fatty acid composition and cheese texture and appearance from cows fed hay or different grazing systems on upland pastures. ***Journal of Dairy Science*** 94, 1132-1145.
12. COUVREUR S., HURTAUD C., LOPEZ C., DELABY L., PEYRAUD J.L., 2006 – The linear relationship between the proportion of fresh grass in the cow diet, milk fatty acid composition, and butter properties. ***Journal of Dairy Science*** 89, 1956-69.

13. DE MARCHI M., DAL ZOTTO R., CASSANDRO M., BITTANTE G., 2007 – Milk coagulation ability of five dairy cattle breeds. ***Journal of Dairy Science*** 90, 3986-3992.
14. DESCALZO A.M., ROSSETTI L., PAEZ R., GRIGIONI G., GARCIA P.T., COSTABEL L., NEGRI L., ANTONACCI L., SALADO E., BRETSCHNEIDER G., GAGLIOSTRO G., COMERON E. TAVERNA M.A., 2012 – Differential characteristics of milk produced in grazing systems and their impact on dairy products. In: Milk production – advanced genetic traits, cellular mechanism, animal management and health. ***InTech*** 15, 339-368.
15. DEVOLD T.G., BROVOLD M.J., LANGSRUD T. VEGARUD G.E., 2000 – Size of native and heated casein micelles, content of protein and minerals in milk from Norwegian Red Cattle – effect of milk protein polymorphism and different feeding regimes. ***International Dairy Journal*** 10, 313-323.
16. ELLIS K.A., MONTEIRO A., INNOCENT G.T., GROVE-WHITE D., CRIPPS P., McLEAN W.G., HOWARD C.V., MIHM M., 2007 – Investigation of the vitamins A and E and b-carotene content in milk from UK organic and conventional dairy farms. ***Journal of Dairy Research*** 74, 484-491.
17. FEKADU B., SORYAL K., ZENG S., VAN HEKKEN D., BAH B., VILLAQUIRAN M., 2005 – Changes in goat milk composition during lactation and their effect on yield and quality of hard and semi-hard cheeses. ***Small Ruminant Research*** 95, 55-63.
18. FELENCZAK A., FERTIG A., GARDZINA E., ORMIAN M., TRELA J., 2006 – Technological traits of milk of Simmental cows as related to k-casein polymorphism. ***Annals of Animal Science*** 6, 37-43.
19. GONZALEZ S.S., DUNCAN S.E., O'KEEFE S.F., SUMNER S.S., HERBEIN J.H., 2010 – Oxidation and Textural Characteristics of Butter and Ice Cream with Modified Fatty Acid Profiles. ***Journal of Dairy Science*** 86, 70-77.
20. GUIMONT C., MARSHALL E., GIRARDET J.M., LINDEN G., 1997 – Biologically active factors in bovine milk and dairy by products: influence on cell culture. ***Critical Reviews in Food Science and Nutrition*** 37, 393-410.
21. JÓŹWIK A., STRZAŁKOWSKA N., BAGNICKA E., ŁAGODZIŃSKI Z., PYZEL B., CHYLIŃSKI W., CZAJKOWSKA A., GRZYBEK W., SŁONIEWSKA D., KRZYŻEWSKI J., HORBAŃCZUK J.O., 2010 – The effect of feeding linseed cake on milk yield and milk fatty acid profile in goats. ***Animal Science Papers and Reports*** 28 (3), 245-251.
22. KALAČ P., 2011 – The effects of silage feeding on some sensory and health attributes of cow's milk: A review. ***Food Chemistry*** 125, 307-317.
23. LIPIŃSKI K., STASIEWICZ M., RAFAŁOWSKI R., KALINIEWICZ J., PURWIN C., 2012 – Effect of milk production season on profile of fatty acids in milk fat. ***Food. Science. Technology. Quality*** 80, 72-80. In Polish, with English summary.
24. LITWIŃCZUK Z., KOWAL M., BARŁOWSKA J., 2014 – Basic chemical composition, proportion of fatty acids, and cholesterol content in milk of four breeds of cows used in the intensive husbandry technologies. ***Food. Science. Technology. Quality*** 4, 108-121. In Polish, with English summary.
25. LITWIŃCZUK Z., TETER U., TETER W., SIANEK P., CHABUZ W., 2006 – The effect of some factors on yield and milk quality of cows from family farms. ***Scientific Annals of Polish Society of Animal Production*** 2, 133-140. In Polish, with English summary.
26. MALLIA S., ESCHER F., SCHLICHTHERLE-CERNY H., 2007 – Aroma-active compounds of butter: a review. ***European Food Research and Technology*** 226, 315–325.
27. MARTIN B., VERDIER-METZ I., BUCHIN S., HURTAUD C., COULON J.B., 2005 – How do the nature of forages and pasture diversity influence the sensory quality of dairy livestock products? ***Animal Science*** 81, 205-212.
28. NOZIČRE P., GRAULET B., LUCAS A., MARTIN B., GROLIER P., DOREAU M., 2006 – Carotenoids for ruminants: from forages to dairy products. ***Animal Feed Science and Technology*** 131, 418-50.

29. O`CONNELL J.E., FOX P.F., 2000 – Heat stability of buttermilk. ***Journal of Dairy Science*** 83, 1728-1732.
30. PN-ISO 6658:1998. Sensory analysis. Methodology. General guidance. In Polish.
31. POLÁK O., FALTA D., HANUŠ O., CHLÁDEK G., 2011 – Effect of barn airspace temperature on composition and technological parameters of bulk milk produced by dairy cows of Czech Fleckvieh and Holstein breeds. ***Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*** 59, 271-280.
32. Polish Standard PN-A-86002, 1999. Raw milk. Requirements and tests. In Polish.
33. REMEUF F., COSSIN C., DERVIN C., LONOIR J., TOMASSONE R., 1991 – Relation entre les caractčres physico-chimiques des laits et leur aptitude fromagčre. ***Lait*** 71, 397-421.
34. ROMANZIN A., CORAZZIN M., PIASENTIER E., BOVOLENTA S., 2013 – Effect of rearing system (mountain pasture vs. indoor) of Simmental cows on milk composition and Montasio cheese characteristics. ***Journal of Dairy Research*** 80, 390-399.
35. SAULAIS L., RUFFIEUX B., 2012 – A field experiment to design healthier foods: consumer valuation of butter production processes. ***Food Quality and Preference*** 26, 178-187.
36. SIKIRIC M., BRAJENOVIC N., PAVLOVIC I., HAVRANEK J.L., PLAVLJANIC N., 2003 – Determination of metals in cow's milk by flame atomic absorption spectrophotometry. ***Czech Journal of Animal Science*** 48, 481-486.
37. STRZAŁKOWSKA N., JÓŹWIK A., BAGNICKA E., KRZYŻEWSKI J., HORBAŃCZUK J.O., 2009a – Studies upon genetic and environmental factors affecting the cholesterol content ion cow milk. II. The effect of silage type offered. ***Animal Science Papers and Reports***, 27 (3), 199-206**.**
38. STRZAŁKOWSKA N., JÓŹWIK A., BAGNICKA E., KRZYŻEWSKI J., HORBAŃCZUK K., PYZEL B., HORBAŃCZUK J.O., 2009b – Chemical composition, physical traits and fatty acid profile of goat milk as related to the stage of lactation. ***Animal Science Papers and Repo****rts* 27 (4), 263-272.
39. STRZAŁKOWSKA N., JÓŹWIK A., BAGNICKA E., KRZYŻEWSKI J., HORBAŃCZUK K., PYZEL B., SŁONIEWSKA D., HORBAŃCZUK J.O., 2010 – The concentration of free fatty acids in goat milk as related to the stage of lactation, age and somatic cell count. ***Animal Science Papers and Reports*** 28 (4), 389-396.
40. STRZAŁKOWSKA N., JÓŹWIK A., POŁAWSKA E., ZDANOWSKA-SĄSIADEK Ż., BAGNICKA E., PYZEL B., LIPIŃSKA P., HORBAŃCZUK J.O., 2014 – A relationship between somatic cell count, polymorphic form of β4-defensin and susceptibility of cow milk fat to lipolysis. ***Animal Science Papers and Reports*** 32, 307-316.
41. TAMBOR K., JAWORSKA D., PRZYBYLSKI W., 2015 – Comparison of sensory quality and nutritive value of Polish traditional and conventional butters. ***Advances of Agricultural Sciences Problem*** 581, 103-111. In Polish.
42. TYRISEVÄ A.M., IKONEN T., OJALA M., 2003 – Repeatability estimates for milk coagulation traits and noncoagulation of milk in Finnish Ayrshire cows. ***Journal of Dairy Research*** 70, 91-98.
43. VERDIER-METZ I., COULON J.B., PRADEL P., VIALLON C., ALBOUY H., BERDAGUÉ J.L., 2000 – Effect of the botanical composition of hay and casein genetic variants on the chemical and sensory characteristics of ripened Saint-Nectaire type cheeses. ***Lait*** 80, 361-370.
44. WILLIAMS P.E.V., BALLET N., ROBERT J.C., 1998 – A review of the provision of vitamins for ruminants. In: Proc. of the Preconference Symp. of the Cornell Nutrition Conference 1998. Provision of Vitamins and Amino Acids for Ruminants, Rhone Poulen Animal Nutrition, Anthony, France, 7-37.
45. WILLIAMS R.P.W., 2002 – The relationship between the composition of milk and the properties of bulk milk products. ***Australian Journal of Dairy Technology*** 57, 30-44.