DOI: 10.21005/AAPZ2024.72.4.4

FOLIA POMERANAE UNIVERSITATIS TECHNOLOGIAE STETINENSIS
Folia Pomer. Univ. Technol. Stetin., Agric., Aliment., Pisc., Zootech. 2024, 373(72)4, 37–45

Received 16 Sep 2024
Revised 30 Sep 2024
Accepted 2 Oct 2024

Marian KUCZAJ

ANALYSIS OF UDDER AND TEAT DIMENSIONS OF PRIMIPAROUS COWS WITH REGARD TO THE COUNTRY OF ORIGIN OF THEIR FATHERS

Department of Cattle Breeding and Milk Production, Wroclaw University of Environmental and Life Sciences, Poland

Abstract. The purpose of the study was to analyze the udder and teat dimensions of primiparous cows, taking into account the influence of the country of origin of their fathers kept on a large-scale dairy farm. The cows included in the study (n = 99) of the Holstein-Friesian Black-and-White breed were divided into 3 paternal groups: daughters of bulls from Belgium (n = 20), Denmark (n = 28) and the USA (n = 51). Significant ($p \leq 0.05$) differences were found between the country of origin of the fathers and the hind teat length and front teat thickness of their daughters. The selection effects of the cows studied for improving udder suspension height (66 cm) were satisfactory The average length of the front teats ranged from 4.20 (daughters of bulls from Denmark) to 4.50 cm (daughters of bulls from Belgium) and the length of the rear teats ranged from 3.38 (daughters of bulls from Denmark) to 3.88 cm (daughters of bulls from Belgium). Average front teat thickness ranged from 2.34 (daughters of bulls from the US) to 2.54 cm (daughters of bulls from Belgium), and rear teat thickness ranged from 2.23 (daughters of bulls from Denmark) to 2.34 cm (daughters of bulls from Belgium). Average front teat spacing ranged from 12.70 (Belgian bull daughters) to 14.20 cm (US bull daughters), rear teat spacing ranged from 5.29 (Danish bull daughters) to 5.77 cm (US bull daughters), and lateral spacing ranged from 11.10 (Belgian bull daughters) to 11.75 (US bull daughters). The systematics of box, round and flat udders in all the primiparous cows studied was 51.5, 37.4 and 11.1%, respectively. The incidence of cylindrical, funnel-shaped and bottle-shaped teats was 72.7, 27.3 and 0.0%, respectively. Teats with a round end were much more common (63.6%) than those with a pointed (21.2%) and flat (15.2%) end. Selection of cows for milk production traits should take into account the size and shape of the udder and teats.

Key words: udder and teat dimensions and shape, country of origin of the sire, primiparous cows.

INTRODUCTION

Conformation traits of udder and teat size and shape can play an important role in their suitability for easy milking and economic milk production and should be taken into account when selecting cows for dairy use. In leading dairy farming countries, a linear evaluation of type and conformation is conducted according to the recommendations of the International

Corresponding author: Marian Kuczaj, Institute of Animal Husbandry, University of Environmental and Life Sciences, Józefa Chełmońskiego 38c, 51-630 Wroclaw, Poland, e-mail: marian.kuczaj@upwr.edu.pl.

Committee for Animal Recording (ICAR 2023). In the overall evaluation of type and conformation of dairy cows on a 100-point scale, the trait weight for udder conformation is 40% (PFHBiPM 2024). Therefore, the selection of cows for suitability for machine milking creates the need for breeding work based on properly managed selection.

A cow's functional udder should allow easy milking and should not have disqualifying defects. Irregularities in teat and udder structure make it difficult (or even impossible) to carry out machine milking in both the conventional system (conventional milking system, CMS) and the automated milking system (automated milking system, AMS). Matching the liners to the dimensions of the cow's teats has a significant impact on the quality of the milking apparatus while ensuring that the teats are milked properly (Luberański et al. 2011). Both the shape of the udder and the shape of the teat and its tips are among the factors that can predispose to the development of mastitis, so it is important that they have a desirable morphological structure so that they are less susceptible to pathogens (Kuczaj 2002, 2003; Uzmay et al. 2003; Haghkhah et al. 2011; Saleh et al. 2023).

Udder and teat conformation traits are highly heritable (h2 = 0.28–0.32) and can serve as marker traits for selection to reduce mastitis in dairy cattle (Bradford et al. 2015). It has been observed that teats that are too thin or too short cause the milking apparatus to fall off, teats that are too thick or too long are heavily compressed by the milking cups, which can result in damage to the mammary gland. Also, a sagging udder makes machine milking and all zoohygienic procedures more difficult and less resistant to any mechanical trauma (Kuczaj 2002). The body of knowledge presented here can help veterinarians outline a more reliable prognosis for the future health of the udder and the continued dairy use of cows. The results of udder and teat morphometry tests as selection criteria can provide dairy farmers with practical information in the implementation of breeding work in the barn.

The purpose of this study was to make a zootechnical evaluation of the external structure of the udder and teats of primiparous cows, taking into account the influence of the country of origin of their fathers.

MATERIAL AND METHODS

The study included 99 primiparous cows of the Polish Holstein-Friesian Black-and-White (phf HO) breed used in a large-scale dairy farm located in southwestern Poland. The experimental cows were daughters of bulls from Belgium (n = 20), Denmark (n = 28) and the USA (n = 51). The cows were kept in an alcove, free-stall system and fed a Total Mixed Ration (TMR) ration system. Milking was carried out twice a day in a side-by-side milking parlor. The entire cow herd was healthy, had correct welfare conditions and was under constant veterinary supervision.

The external structure of the udder and teats was determined by a single measurement on approximately the 100th day of lactation just before the evening milking at the milking parlor stand. Cows free of clinical signs of mastitis (milk of normal consistency and a mammary gland without pathological changes such as swelling, redness or signals of pain sensation during pre-milking routines) were qualified for the study.

Zoometric measurements of the udder were taken using a zoometric tape, a ruler and a universal caliper. The study included, among others:

1. Udder measurements in cm: suspension height, front and rear teat length, front and rear teat thickness, lateral, front and rear teat spacing; measurements were made according to Kuczaj's (2003) methodology, according to the scheme (Fig. 1).

2. Udder and teat structure characteristics: teat shape (cylindrical, funnel-shaped, bottle-shaped), teat end (round, flat, pointed), udder construction (box-shaped, round, flat) based on visual inspection.

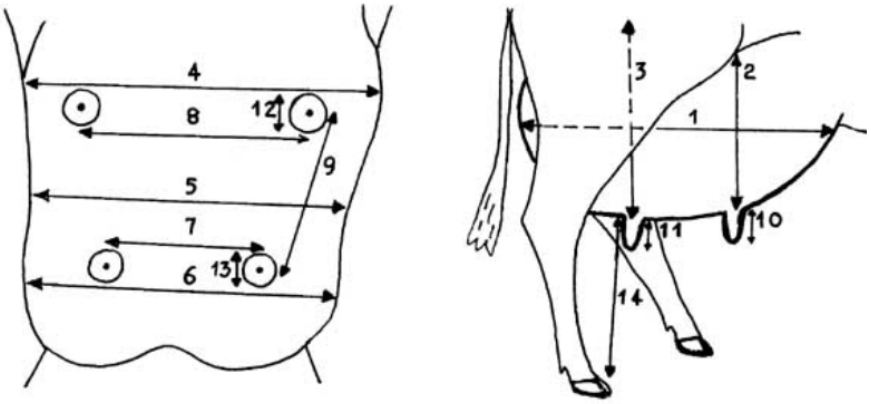

Fig. 1. Diagram of udder measurement of cows: 7 – rear teat spacing, 8 – front teat spacing, 9 – lateral spacing (front to back), 10 – front teat length, 11 – rear teat length, 12 – front teat thickness, 13 – rear teat thickness, 14 – udder suspension height.
Source: Kuczaj (2003)

In the study of udder and teat dimensions, their mean values ($\bar{x}$) and standard deviation (SD) were determined. The chi-square test of independence was used to determine the presence of statistically significant differences. Differences between means were considered significant at $p \leq 0.05$.

The reported relative and absolute advantages of the udder and teat parameters studied were referred to the group of progeny by US bulls (taken as 100%). The systematics of different – types – of udder and teat conformation is presented, giving their abundance and frequency of evaluation (in %).

RESULTS AND DISCUSSION

Table 1 summarizes the differences in external udder and teat morphometric traits of primiparous cows depending on the country of origin of their fathers.

The analysis showed a statistically significant effect of the bull's country of origin ($p \leq 0.05$) on hind teat length and front teat thickness in their daughters. With regard to the other analyzed parameters of udder and teat conformation, no significant differences were shown. Selection for improved udder-to-floor distance (more than 66 cm) proved effective. Daughters by fathers from the USA had udders hanging minimally lower than peers by bulls from Denmark (by 0.03 cm, relative difference 0.4%), and significantly higher than daughters by bulls from Belgium (by 0.33 cm; relative difference 0.50%).

The results of self-reported measurements of the udder distance from the ground (>66 cm) are significantly higher than those found previously; 51.4 cm in primiparous phf cows with a black and white coat and 45.4 cm in Holstein-Friesian peers with a red and white coat (Kuczaj 2002). The presence of high and tightly hung udders in dairy cows is associated with the occurrence of fewer somatic cells (SCCs) in milk and reduces the susceptibility to developing mastitis (Singh et al. 2013; Bansal 2024; Sharma and Singh 2024).

Table 1. The effect of the country of origin of the bull on the udder and teat morphometry of primiparous cows

Traits		Country of origin of the sire			p
		Belgium (n = 20)	Denmark (n = 28)	USA (n = 51)	
Height of udder suspension [cm]	$\tilde{x}$	66.05	66.41	66.38	0.934
	SD	3.48	3.42	3.97	
Front teat length [cm]	$\tilde{x}$	4.50	4.20	4.34	0.441
	SD	0.95	0.84	0.73	
Rear teat length [cm]	$\tilde{x}$	3.88[a]	3.38[b]	3.64	0.039
	SD	0.79	0.60	0.65	
Thickness of front teats [cm]	$\tilde{x}$	2.54[a]	2.37	2.34[b]	0.019
	SD	0.36	0.24	0.22	
Rear teat thickness [cm]	$\tilde{x}$	2.34	2.23	2.25	0.208
	SD	0.25	0.20	0.24	
Front teat spacing [cm]	$\tilde{x}$	12.70	13.59	14.20	0.109
	SD	2.84	2.85	2.54	
Rear teat spacing [cm]	$\tilde{x}$	5.40	5.29	5.77	0.620
	SD	2.51	2.14	2.25	
Lateral teat spacing: front to back [cm]	$\tilde{x}$	11.10	11.57	11.75	0.523
	SD	1.61	2.01	2.37	

a, b – determination of means in rows statistically significantly different at $p \leq 0.05$.

The length of the front teats in cow-daughters by US fathers was greater than peers by bulls from Denmark (by 0.14 cm; a relative difference of 3.23%) and less than peers by bulls from Belgium (by 0.16 cm; a relative difference of 3.69%). Primiparous females by fathers from the US had hind teats longer compared to cows by fathers from Denmark (by 0.26 cm; relative difference 7.14%), and shorter compared to daughters by fathers from Belgium (by 0.24 cm; relative difference 6.59%).

The results of our own measurements are significantly smaller to the literature data; the average length of the front and rear teats ranged from 5.3 and 4.5 cm, respectively (Luberański et al. 2011) to 6.06 and 4.94 cm (Kuczaj 2002). Tilki et al. (2005) found a negative correlation between milk yield and front and rear teat length (milk yield of cows decreased as teat length increased). Porcionato et al. (2010) observed rapid milk flow in cows having teat canals of shorter length. A similar trend was found by Saleh et al. (2023) that teat morphology is part of a passive defense mechanism against intra-exchange infection, so short teats are more favorable for cows with high milk production than long teats.

The average thickness of front teats in cow-daughters by US sire was minimally less than peers by bulls from Denmark (by 0.03 cm; a relative difference of 1.28%) and significantly less than peers by bulls from Belgium (by 0.20 cm; a relative difference of 8.5%). The average thickness of the hind teats of cows by sire bulls from the US was minimally greater than the peers sired by bulls from Denmark (by 0.02 cm; a relative difference of 0.9%) and slightly lower than peers sired by bulls from Belgium (by 0.09 cm; a relative difference of 4.0%).

The results of our own measurements were slightly lower than those found previously in other studies of the national population of Holstein-Friesian cows, i.e. from 2.6 cm (Luberański

et al. 2011) to 3.0 cm (Kuczaj 2002). According to Sharma and Singh (2024), teat thickness and length are traits that have a significant impact on milk yield (they affect daily milk yield, milk flow and mammary gland infections). According to the cited authors, shorter teats are desirable because cows with long teats experience difficulties during mechanical milking and are more susceptible to injury. Uzmay et al. (2003) showed that the risk of subclinical mastitis was highest in hf cows having long and thick teats. According to other researchers (Haghkhah et al. 2011; Bansal 2024), mastitis occurs less frequently in cows with smaller-diameter teats. According to Singh et al. (2013), cows with teat lengths >4.5 cm and teat diameters ≥3.0 cm had significantly more quarters affected by mastitis.

The distance between the front teats was more than double that of the rear teats. The average front teat spacing in cow-daughters by US sire was slightly greater than peers by bulls from Denmark (by 0.61 cm; a relative difference of 4.49%) and significantly greater than peers by bulls from Belgium (by 1.50 cm; a relative difference of 11.81%). The average posterior teat spacing of cows-daughters by US sires was slightly larger than peers by bulls from Denmark (by 0.48 cm; relative difference 8.32%) and minimally larger than peers by bulls from Belgium (by 0.37 cm; relative difference 6.41%). The average lateral teat spacing in cows-daughters by US sire was minimally larger than peers by bulls from Denmark (by 0.22 cm; relative difference 1.53%) and significantly larger than peers by bulls from Belgium (by 0.65 cm; relative difference 5.53%). In other studies in phf HO cows, the front and rear teat spacing and their lateral spacing were 19.1 10.9 and 13.3 cm, respectively (Kuczaj 2002).

According to Tilki et al. (2005), the distances between the front teats, the rear teats and the lateral distance of the teats are positively correlated with the milk yield of cows (their milk yield increased with increasing the distance between the teats). Kuczaj (2003) found a small positive correlation coefficient between the number of somatic cells in milk and the distance between the rear teats (milk hygienic quality increased with increasing side teat spacing). In another study (Bansal 2024), no significant relationship was found between udder health and teat spacing, despite the fact that teat spacing was slightly smaller for individuals more likely to develop mastitis.

Table 2 shows the systematics of udder shape types in primiparous cows by country of origin of their sire.

Table 2. Influence of a bull's country of origin on the udder conformation type of his daughters

Country of origin of bulls	Type of udder structure						Total n, %
	boxed		round		flat		
	n	%	n	%	n	%	
Belgium	8	40.0	7	35.0	5	25.0	20 (20.2)
Denmark	20	71.4	6	21.4	2	7.2	28 (28.3)
USA	23	45.1	24	47.1	4	7.8	51 (51.5)
Total	51	51.5	37	37.4	11	11.1	99 (100)

The systematics of the different types of udder conformation of the 99 cows studied: boxy, round and flat were 51.5, 37.4 and 11.1%, respectively. The highest percentage of cows with the desired boxy udder conformation was sired by bulls from Denmark (71.43%) and compared to peers sired by bulls from the US and Belgium, it was 26.3 and 31.4% higher,

respectively. The highest percentage of cows with round udder conformation had cows, daughters sired by bulls from the USA (47.1%) and compared to peers sired by bulls from Belgium and Denmark was higher by 12.1 and 25.7%, respectively. The highest percentage of cows with flat udder conformation came from bulls from Belgium (25.0%) and compared to peers sired by bulls from Denmark and the US was higher by 17.8 and 17.2%, respectively.

The results of Uzmay et al. (2003) indicate that cows with box-shaped udders had the lowest risk of subclinical mastitis, while cows with round udders had the highest risk. Also, Bansal (2024) found that the shape of the udder was significantly related to the incidence of mastitis; cows with round udders were more susceptible to infection compared to udders of other conformation. Brzozowski (2003), on the other hand, showed that udder infections were least common in cows with box-shaped udders.

Table 3 shows the results on the frequency of different teat shapes in daughters by bulls from Belgium, Denmark and the USA.

Table 3. Influence of a bull's country of origin on the teat shape of his daughters

Country of origin of bulls	Types of teat structures						Total n, %
	cylindrical		funnelled		bottle		
	n	%	n	%	n	%	
Belgium	16	80.0	4	20.0	0	0.0	20 (20.2)
Denmark	18	64.3	10	35.7	0	0.0	28 (28.3)
USA	38	74.5	13	25.5	0	0.0	51 (51.5)
Total	72	72.7	27	27.3	0	0.0	99 (100)

It was found that among all 99 cows studied, the desired cylindrical teat shape was most common (72.7%), while funnel-shaped teats were much less common (27.3%). Cylindrical teats were more common in daughters sired by fathers from Belgium (80.0%) than in peers sired by bulls from the US and Denmark by 5.5 and 15.7%, respectively.

Table 4 shows data on the incidence of different types of teat ends in daughters by bulls of Belgium, Danish and US origin.

Table 4. Influence of a bull's country of origin on the teat end type of his daughters

Country of origin of bulls	Types of teat structures						Total n, %
	round		flat		pointed		
	n	%	n	%	n	%	
Belgium	12	60.0	2	10.0	6	30.0	20 (20.2)
Denmark	17	60.7	6	21.4	5	17.9	28 (28.3)
USA	34	66.7	7	13.7	10	19.6	51 (51.5)
Total	63	63.6	15	15.2	21	21.2	99 (100)

In the studied population of cows, round teat end was three times more common (63.6%) than those with a pointed end (21.2%) and almost four times more common than those with a flat end (15.2%). The typical round teat end in cow-daughters by US fathers (66.7%) was

more common than in peers by fathers from Denmark and Belgium by 6.0 and 6.7%, respectively. The incidence of flat-tipped teats in daughters by bulls from Belgium (10.0%) was 3.7 and 11.4% lower than in peers sired by bulls from the US and Denmark, respectively. In primiparous females by fathers from Belgium, pointed teat ends (30.0%) were more common by 10.4 and 12.1%, respectively, compared to peers by bulls from Denmark and the US.

In a study by Singh et al. (2017), Holstein-Friesian cows had almost twice as many teats with a round end (59.3%) as with a flat end (33.0%). The cited authors noted that the incidence of mastitis was higher for bottle-shaped, conical and normal teats than for very thin (pencil-shaped) teats. Bansal (2024) found that the teat end has a significant effect on the incidence of mechanical damage. There is a higher risk of damage in cows for teats with a pointed end compared to teats with round and flat ends, which could possibly be due to the stress on a smaller teat surface during milking and thus the difficulty of milking. According to Haghkhah et al. (2011), pointy-tipped teats have more excessive keratinization and lesions, while flat-tipped teats tend to milk slower but cause less infection.

CONCLUSIONS

The demonstrated variation in the udder conformation of cows and in the size and shape of both front and rear teats is probably a genetic effect resulting from the diversity of breeding programs used in the various countries from which sire semen straws are imported. The results of the study provide valuable information (as selection criteria) for use in improving dairy cattle using semen from bulls from Belgium, Denmark and the US.

Based on the study, the following conclusions can be made:

1. The country of origin of the sire differentiates statistically significantly at $p \leq 0.05$ between the studied groups of cows in terms of hind teat length and front teat thickness.
2. Selection of cows for optimal udder and teat morphometry in breeding programs is possible.
3. In the studied herd of primiparous cows, improvement of udder suspension height (66 cm from the ground) was effective.
4. In order to standardize teat length and thickness, stabilizing selection should be carried out by using in breeding bulls whose daughters, primiparous cows have front and rear teat lengths of 4.50 and 3.90 cm, respectively, and front and rear teat thicknesses of 2.55 and 2.35 cm, respectively.

REFERENCES

Bansal B.K. 2024. Udder and teat morphometry in relation to udder health and milk quality in dairy cows. Short cource on evolving trends in applied anatomy and its implications in veterinary clinical practice. Bathinda, Punjab 7–16 February 2024, 20–32.

Bradford H.L., Moser D.W., Minick Bormann J., Weaber R.L. 2015. Estimation of genetic parameters for udder traits in Hereford cattle. J. Anim. Sci. 93(6), 2663–2668. DOI: 10.2527/jas2014-8858.

Brzozowski P. 2003. Znaczenie budowy wymienia w hodowli bydła [The importance of udder structure in cattle breeding]. Prz. Hod. 12, 12–15 [in Polish].

Haghkhah M., Ahmadi M.R., Gheisari H.R., Kadivar A. 2011. Preliminary bacterial study on subclinical *mastitis* and teat condition in dairy herds around Shiraz. Turk. J. Vet. Anim. Sci. 35(6), 387–394. DOI: 10.3906/vet-0907-81.

ICAR. 2023. Section 5 – ICAR Guidelines for Conformation Recording of Dairy Cattle, Beef Cattle, Dual Purpose Cattle and Dairy Goats. Ver. January, 2023.

Kuczaj M. 2002. Wielkość wymion krów czarno- i czerwono-białych w aspekcie ich przydatności do doju maszynowego [Estimation of the utilility of Black- and Red-White cows for mechanical milking]. Med. Weter. 58(7), 552–555 [in Polish].

Kuczaj M. 2003. Analysis of changes in udder size of high-yelding cows in subsequent lactations with regard to mastitis. Electronic J. Pol. Agric. Univ., Ser. Anim. Husb. 6(1), 2–5.

Luberański A., Krzyś A., Szlachta J., Wiercioch M. 2011. Analiza wymiarów krowich strzyków przed i po przeprowadzonym doju mechanicznym w wybranych fermach bydła mlecznego [Analysis of the cow teats' dimensions before and after machine milking in selected dairy cattle farms]. Probl. Inż. Rol. 19(1), 95–103 [in Polish].

PFHBiPM. 2024. Ocena typu i budowy krów ras mlecznych – PFHBiPM, https://pfhb.pl/hodowla/ocena-typu-i-budowy-bydla-mlecznego/ocena-typu-i-budowy-krow-ras-mlecznych, acces: 16.09.2024 [in Polish].

Porcionato M.A., Soares W.V., Reis C.B., Cortinahas C.S., Mestieri L., Santos M.V. 2010. Milk flow, teat morphology and subclinical mastitis prevalence in Gir cows. Pesq. Agropec. Bras. 45(12), 1507–1512. DOI: 10.1590/S0100-204X2010001200023.

Saleh A.S., Easa A.E., El-Hedainy D.K., Rashad A.M. 2023. Prediction of some milk production traits using udder and teat measurements with a spotlight on their genetic background in Friesian cows. Sci. Rep. 13(1), 16193. DOI: 10.1038/s41598-023-43398-y.

Sharma A., Singh Y. 2024. Welfare implications of morphometric changes associated with production oriented breeding in livestock, in: Evolving Trends in Applied Anatomy and its Implications in Veterinary Clinical Practice. Eds. O.P. Choudhary. Rampura Phul: College of Veterinary Science, 63–68.

Singh R.S., Bansal B.K., Gupta D.K. 2013. Udder health in relation to udder and teat morphometry in Holstein-Friesian × Sahiwal crossbred dairy cows. Trop. Anim. Health Prod. 46(1), 93–98. DOI: 10.1007/s11250-013-0454-8.

Singh R.S., Bansal B.K., Gupta D.K. 2017. Relationship between teat morphological traits and subclinical mastitis in Frieswal dairy cows. Trop. Anim. Health Prod. 49, 1623–1629. DOI: 10.1007/s11250-017-1368-7.

Tilki M., İnal Ş., Colak M., Garip M. 2005. Relationships between milk yield and udder measurements in Brown Swiss cows. Turk. J. Vet. Anim. Sci. 29(1), 75–81.

Uzmay C., Kaya Y., Akbas Y., Kaya A. 2003. Effects of udder and teat morphology, parity and lactation stage on subclinical *mastitis* in Holstein cows. Turk. J. Vet. Anim. Sci. 27, 695–701.

ANALIZA WYMIARÓW WYMION I STRZYKÓW KRÓW PIERWIASTEK Z UWZGLĘDNIENIEM KRAJU POCHODZENIA ICH OJCÓW

Streszczenie. Celem badań była analiza wymiarów wymion i strzyków krów pierwiastek z uwzględnieniem wpływu kraju pochodzenia ich ojców utrzymywanych w wielkostadnej fermie bydła mlecznego. Objęte badaniami krowy (n = 99) rasy holsztyńsko-fryzyjskiej odmiany czarno-białej podzielono na 3 grupy ojcowskie: córki buhajów pochodzących z Belgii (n = 20), Danii (n = 28) oraz z USA (n = 51). Stwierdzono występowanie istotnych ($p \leq 0,05$) różnic między krajem pochodzenia ojców a długością strzyków tylnych i grubością strzyków przednich u ich córek. Efekty selekcji badanych krów w kierunku poprawy wysokości zawieszenia wymion (66 cm) były zadowalające. Średnia długość strzyków przednich

mieściła się w zakresie od 4,20 (córki buhajów z Danii) do 4,50 cm (córki buhajów z Belgii), a długość strzyków tylnych od 3,38 (córki buhajów z Danii) do 3,88 cm (córki buhajów z Belgii). Średnia grubość strzyków przednich wynosiła od 2,34 (córki buhajów z USA) do 2,54 cm (córki buhajów z Belgii), grubość strzyków tylnych od 2,23 (córki buhajów z Danii) do 2,34 cm (córki buhajów z Belgii). Średni rozstaw strzyków przednich wynosił od 12,70 (córki buhajów z Belgii) do 14,20 cm (córki buhajów z USA), rozstaw strzyków tylnych od 5,29 (córki buhajów z Danii) do 5,77 cm (córki buhajów z USA), a rozstaw boczny – od 11,10 (córki buhajów z Belgii) do 11,75 (córki buhajów z USA). Systematyka wymion skrzynkowatych, okrągłych i płaskich u wszystkich badanych krów pierwiastek wynosiła odpowiednio 51,5%, 37,4% i 11,1%. Frekwencja występowania strzyków o kształcie cylindrycznym, lejkowatym i butelkowym wyniosła odpowiednio 72,7%, 27,3% i 0,0%. Strzyki o zakończeniu okrągłym występowały znacznie częściej (63,6%) niż o zakończeniu spiczastym (21,2%) i płaskim (15,2%). Selekcja krów pod kątem cech produkcji mleka powinna uwzględniać wymiary i kształt wymienia oraz strzyków.

Słowa kluczowe: wymiary i kształt wymion i strzyków, kraj pochodzenia reproduktora, krowy pierwiastki.