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Slaughter value and meat quality of goat kids with various share of Boer blood

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Investigations were conducted on one group of White Improved (WI) kids and three groups of WI crossbred kids with various share of the Boer (B) genes: 1/4B3/4WI, 1/2B1/2WI and 3/4B1/4WI. Eighteen male kids were included in each group. Up to 20 kg life weight the kids of all groups had free access to their dams' milk and to solid feed from day 14 of life.
Crossbreds with 25, 50 and 75% of the B genes reached slaughter weight by 8, 19 and 23 days earlier, respectively, than WI kids (95 days). All crossbreds showed higher dressing percentage, their carcasses were covered with a thicker fat layer over the ribs and over the *longissimus dorsi* (LD) muscle and were characterized by lower chilling losses compared to WI kids. In turn, with increasing share of B genes in genotype the fat content of carcass increased and the bone content decreased. Slight differences were found in dry matter and crude protein contents as well as pH measured 45 min and 24 h post-slaughter in the LD between the crossbred and WI kids. In crossbreds with a 50 and 75% of the B genes a higher share of intramuscular fat as well as lower thermal drip and water-holding capacity were recorded. Sensory evaluation showed the lowest meat tenderness and juiciness in WI kids.

KEY WORDS: carcass /goat kids / meat quality /slaughter value /sensory evaluation

Production of young slaughter kids is common in well-developed countries [Shrestha and Fahmy 2005, Webb *et al*. 2005]. France, Greece, Spain and Italy are primary producers and at the same time primary consumers of meat of young goats. In those countries the biggest demand, especially around Christmas and Easter is for lean

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carcasses of milk-fed kids [Dubeuf *et al*. 2004, Todaro *et al*. 2004]. In Poland, goat meat due to lack of any tradition of its consumption may not be purchased in retail and connoisseurs may only buy it directly from goat breeders. In this country goat (kid) meat is a by product in farms keeping dairy goats. Male kids of a dairy breed due to their low carcass quality are a burden for owners of milk producing farms, thus most frequently are not reared. However, the growing interest of Polish consumers in healthy feeding can lead to the increase in the consumption of high-quality goat meat in the near future. In consequence, interest in male kid rearing may be increased by improving their carcass quality as a result of mating of dairy breed females to bucks of a meat breed [Szymanowska 2000].

So far, available information on slaughter value of milk-kids coming from crossing of native dairy goats with meat goats [Bidwell-Porębska *et al*. 1995, Stanisz and Gut 2003, Kuźnicka *et al*. 2004] is insufficient. The aim of this study was to assess the slaughter value and carcass and meat quality of crossbred male kids with varying share of the Boer breed, suckling up to 20 kg live weight.

Material and methods

Investigations were conducted at the Złotniki Experimental Station of the Department of Sheep, Goat and Fur Animals Breeding, University of Life Sciences in Poznań on 72 male kids of four groups (n=18) according to an orthogonal data design: Polish White Improved (WI) and three groups of crossbreds with various share of Boer (B) genes and being the progeny of three B sires, imported from Germany. The following crossbred groups were arranged: 1/4B3/4 WI, 1/2B1/2WI and 3/4B1/4WI. The kids (all born as twins) were kept suckling up to 20 kg live weight as their dams were not milked at all. Starting from day 14 of life all kids were additionally fed rolled oats, concentrate mix composed of crushed wheat and barley grain, wheat middlings, post-extractive rapeseed meal (15.8% crude protein, 6.9 MJ ME/kg) and meadow hay *ad libitum.* Dams during the suckling period were fed farm-produced feeds in accordance with standards for goats suckling twins [National Research Institute of Animal Production 1993]. Over 12 hours before slaughter the kids were fasted with free access to water. Direct before slaughter the kids were weighed accurate to 0.1 kg.

Immediately post-slaughter the carcasses were weighed and warm dressing percentage, while after 24 h chilling at 2-4°C their cold dressing percentage was determined. On cold carcasses the following measurements were taken: outside carcass length, breast depth, breast width, rump width and leg cercumference.

Carcasses were cut and jointed according to Nawara *et al*. [1963]. Carcass tissue composition was determined based on complete carcass-side dissection (into muscle, fat and bones). Cuts and tissues were weighed accurate to 1 g.

The cross-section area of the *longissimus dorsi* (LD) muscle, the thickness of fat layer over the LD and over the ribs were measured on the posterior part of best end of the neck (behind the 13 thoratic vertebra) by scanning to a computer with a definition of 800 ppi, at a 32-bit depth of colours. Images were stored in a form of disc files (a bit map) and measured using a MultiScan ver. 12.07 software package [MultiScan 2001].

Meat quality was analysed on LD samples collected after 24 h chilling. In order to determine water content the samples were dried at 105°C to constant weight. Crude fat was determined according to Soxhlet, crude protein according to Kjeldahl, thermal drip after Walczak [1959] and water-holding capacity (WHC) after Pohja and Niinivaara [1957]. The pH was measured in the LD muscle with a glass-calomel combined electrode, 45 min and 24 h post-slaughter.

Sensory evaluation of the LD muscle was performed in all kids. Collected samples were boiled in a 0.6% NaCl solution until a temperature of 80°C was reached within the muscle block. After boiling and chilling meat was cut into slices about 4 mm thick. Sensory attributes (taste, aroma, tenderness and juiciness) were assessed by five independent panelists using a 10 cm graphic scale, which was next converted into a point score scale accurate to 0.1 points.

The effect of genotype on carcass quality was estimated with ANOVA procedure of SAS ver. 6.12 software package (SAS 1998]. In order to evaluate the effect of genotype on sensory value of meat the non-parametric analysis of variance (Kruskal-Wallis test) was used.

Results and discussion

Crossbred kids with 25, 50 and 75% of the B genes reached the assumed slaughter weight by 8 ($P \leq 0.05$), 19 ($P \leq 0.01$) and 23 ($P \leq 0.01$) days earlier, respectively, than WI kids (Tab 1). The advantageous effects of mating goats of dairy breeds to B bucks on life weight of crossbred kids were reported in Poland by Bidwell-Porębska *et al*. [1955], Kalinowska *et al*. [1977], Kuźnicka *et al*. [2004] and Stanisz and Gut [2004].

The highest warm and cold carcass weights were recorded in 1/2B1/2WI and 3/4B1/4WI crossbreds and the respective values were higher than those found in 1/4B3/4WI ($P \leq 0.05$) and pure WI kids. The 1/2B1/2WI and3/4B1/4WI crossbreds did not differ significantly in terms of warm and cold carcass weights and simultaneously they had higher warm and cold carcass weights than 1/4B3/4WI and WI kids ($P \leq 0.05$) – Table 1. The results reported here confirm the positive effect of Boer sires on dressing percentage in crossbreds both milk-fattened up to16 kg live weight [Bidwell-Porębska *et al*. 1995] or fattened to the age of 100 [Stanisz and Gut 2003] and 150 days [Kuźnicka *et al*. 2004].

The smallest loss of carcass weight after 24 h chilling was recorded in 3/4B1/4WI crossbreds (2.35%). These kids showed a smaller carcass weight loss than 1/2B1/2WI crossbreds (by 0.7 per cent points, $P \leq 0.05$) and 1/4B3/4WI crossbreds (by 1.6 per cent points, $P \leq 0.01$) or WI kids (by 2.16 per cent points, $P \leq 0.01$) – Table 1. The authors of similar studies (Sen *et al*. 2004, Stanisz and Gut 2005] reported that the layer of subcutaneous fat has a large impact on carcass chilling loss. This is confirmed by this report in which carcasses of crossbreds showed a much thicker fat layer over the LD

Table 1. Least squares means (LSM) and their standard errors (SE) for slaughter value indicators in kids

Indicator		Kid genotype: White Improved (n=18)	¼ Boer ¾ White Improved (n=18)	½ Boer ½ White Improved (n=18)	¾ Boer ¼ White Improved (n=18)	Effect of genotype
Body weight at slaughter (kg)	LSM	19.95	20.12	20.13	20.08	ns
	SE	0.22	0.11	0.27	0.21	
Age at slaughter (days)	LSM	95	87	76	72	**
	SE	3^{Aca}	2^{BDa}	3^{AB}	3^{CD}	
Dressing percentage (warm)	LSM	49.31	51.32	53.28	52.91	**
	SE	0.78^{ABa}	0.72^{abc}	0.63^{Ab}	0.63^{Bc}	
Dressing percentage (cold)	LSM	47.07	49.31	51.63	51.63	**
	SE	0.65^{ABa}	0.67^{bac}	0.52^{Ab}	0.52^{Bc}	
Carcass weight (kg, warm)	LSM	9.76	10.37	10.81	10.68	*
	SE	0.24^{abc}	0.25^{a}	0.28^{b}	0.21^{c}	
Carcass weight (kg, cold)	LSM	9.32	9.96	10.48	10.43	**
	SE	0.22^{ABa}	0.21^{a}	0.23^{A}	0.21^{B}	
Chilling loss after 24 h (%)	LSM	4.51	3.95	3.05	2.35	**
	SE	0.11^{ABa}	0.11^{Cab}	0.12^{Abc}	0.11^{BCc}	

$^{aA...}$Means within rows bearing the same superscripts are significantly different at: small letters – P≤0.05; capitals – P≤0.01.
*P≤0.05; **P≤0.01; ns – non-significant.

Table 2. Least squares means (LSM) and their standard errors (SE) for carcass dimensions in kids

Indicator		Kid genotype: White Improved (n=18)	¼ Boer ¾ White Improved (n=18)	½ Boer ½ White Improved (n=18)	¾ Boer ¼ White Improved (n=18)	Effect of genotype
Outside carcass length (cm)	LSM	53.42	52.53	52.38	51.18	ns
	SE	0.82	0.79	0.67	0.72	
Breast depth (cm)	LSM	22.63	22.98	23.12	22.92	ns
	SE	0.42	0.53	0.58	0.51	
Breast width (cm)	LSM	13.82	14.62	14.58	14.53	ns
	SE	0.38	0.42	0.43	0.33	
Rump width (cm)	LSM	16.92	17.83	18.21	18.93	*
	SE	0.29^{abc}	0.37^{a}	0.52^{b}	0.42^{c}	
Leg circumference (cm)	LSM	23.53	25.13	25.59	26.39	*
	SE	0.53^{abc}	0.50^{a}	0.48^{b}	0.34^{c}	
Fat layer thickness over LD (mm)	LSM	1.00	1.10	1.42	1.63	**
	SE	0.22^{AD}	0.15^{BC}	0.18^{CD}	0.21^{AB}	
Fat layer thickness over ribs (mm)	LSM	1.15	1.19	1.54	1.75	**
	SE	0.21^{AD}	0.24^{BC}	0.36^{CD}	0.36^{AB}	
Cross-section area of LD (cm^2)	LSM	5.62	6.12	7.18	7.35	**
	SE	0.39^{AB}	0.45^{CD}	0.49^{AC}	0.54^{BD}	

LD – *longissimus dorsi* muscle.
$^{aA...}$Means within rows bearing the same superscripts are significantly different at: small letters – P≤0.05; capitals – P≤0.01. *P≤0.05; **P≤0.01; ns – non-significant.

muscle and over the ribs than carcasses of purebred WI kids (Tab. 2).The effect of the Boer goat on the thickness of subcutaneous fat in crossbreds with the White Improved breed has also been reported by Kuźnicka *et al*. [2004].

The positive effects of Boer breed on better rounding of the leg (a wider rump, a larger leg circumference – Table 2) and on the leg weight content of carcass (Tab. 3) found in this study in crossbred kids corroborate the results reported by Stanisz and Gut [2003] who studied crossbred kids containing 50 and 75% Boer genes in their genotype in fattening up to the age of 100 days.WI and crossbred kids showed similar meat content of carcass (63.71-64.83% – Table 4). The lowest content of fat was recorded of WI carcasses (10.11%). Simultaneously with an increase of the share of B genes, the per cent of fat increased to 15.31% in crossbreds with a 75% share of B breed (P≤0.01). The highest content of bones was found in WI carcasses (25.06%), whereas with an increase in the share of B genes in the genotype, the bone content

Table 3. Least squares means (LSM) and their standard errors (SE) for primary cuts and kidney fat content (%) of carcass-sides in kids

Indicator		Kid genotype				
		White Improved (n=18)	¼ Boer ¾ White Improved (n=18)	½ Boer ½ White Improved (n=18)	¾ Boer ¼ White Improved (n=18)	Effect of genotype
Leg	LSM	21.18	21.53	22.59	23.09	*
	SE	0.26^{ab}	0.31^{c}	0.29^{a}	0.25^{bc}	
Rump	LSM	6.38	6.62	6.68	6.72	ns
	SE	0.13	0.12	0.12	0.12	
Best end of neck	LSM	6.63	6.58	6.51	6.65	ns
	SE	0.16	0.15	0.15	0.15	
Fillet	LSM	1.14	1.18	1.24	1.28	*
	SE	0.03^{ab}	0.02^{c}	0.03^{a}	0.04^{bc}	
Shoulder	LSM	14.25	14.28	14.83	14.65	ns
	SE	0.21	0.19	0.21	0.28	
Neck	LSM	12.08	12.11	11.65	11.53	ns
	SE	0.24	0.24	0.23	0.21	
Flank with ribs	LSM	16.81	16.72	17.06	16.82	ns
and breast bone	SE	0.39	0.28	0.46	0.39	
Hind shank	LSM	6.61	6.51	6.12	6.02	ns
	SE	0.12	0.11	0.12	0.13	
Fore shank	LSM	6.25	6.18	6.08	6.07	ns
	SE	0.14	0.12	0.11	0.14	
Scrag	LSM	8.69	8.29	7.62	7.54	ns
	SE	0.32	0.29	0.42	0.51	
Kidney fat	LSM	1.85	2.07	4.11	4.07	**
	SE	0.18^{AB}	0.16^{CD}	0.42^{AC}	0.39^{BD}	

$^{aA...}$Means within rows bearing the same superscripts are significantly different at: small letters – P≤0.05; capitals – P≤0.01.
*P≤0.05; **P≤0.01; ns – non-significant.

dropped – in 1/4B3/4WI kids by 1.62 (P≤0.05), in 1/2B1/2 WI by 3.54 (P≤0.01) and in 3/4B1/4WI crossbreds by 4.08 per cent points (P≤0.01) – Table 4. These figures confirm the earlier results obtained by Stanisz and Gut [2003] on Boer crossbreds in

Table 4. Least squares means (LSM) and their standard errors (SE) for carcass tissue composition (%) in kids

Indicator		Kid genotype: White Improved (n=18)	¼ Boer ¾ White Improved (n=18)	½ Boer ½ White Improved (n=18)	¾ Boer ¼ White Improved (n=18)	Effect of genotype
Meat	LSM	64.83	64.32	64.26	63.71	ns
	SE	0.91	0.84	0.98	1.02	
Fat	LSM	10.11	12.24	14.25	15.31	**
	SE	0.49^{ABC}	0.63^{ADa}	0.55^{Ba}	0.54^{CD}	
Bones	LSM	25.06	23.44	21.49	20.98	**
	SE	0.77^{ABa}	0.85^{Cab}	0.72^{Ab}	0.87^{BC}	

$^{aA...}$Means within rows bearing the same superscripts are significantly different at: small letters – P≤0.05; capitals – P≤0.01.
**P≤0.01; ns – non-significant.

Table 5. Least squares means (LSM) and their standard errors (SE) for physical properties and chemical composition of *longissimus dorsi* meat in kids

Indicator		Kid genotype: White Improved (n=18)	¼ Boer ¾ White Improved (n=18)	½ Boer ½ White Improved (n=18)	¾ Boer ¼ White Improved (n=18)	Effect of genotype
Physical properties						
pH 45min	LSM	6.41	6.45	6.35	6.44	ns
	SE	0.04	0.04	0.06	0.06	
pH 24h	LSM	5.55	5.58	5.59	5.57	ns
	SE	0.03	0.03	0.04	0.04	
thermal drip (%)	LSM	35.7	36.1	32.8	33.2	*
	SE	0.6^{ac}	0.6^{bd}	0.5^{cd}	0.4^{ac}	
water holding capacity (%)	LSM	37.3	36.8	33.9	33.4	*
	SE	0.5^{ac}	0.4^{bd}	0.6^{cd}	0.6^{ab}	
Chemical composition (%)						
dry matter	LSM	22.3	21.8	22.0	21.7	ns
	SE	0.2	0.3	0.3	0.3	
crude protein	LSM	20.8	20.4	21.2	20.6	ns
	SE	0.2	0.2	0.3	0.3	
fat	LSM	1.09	1.14	1.52	1.65	**
	SE	0.14^{AB}	0.16^{CD}	0.16^{AD}	0.11^{BC}	

$^{aA...}$Means within rows bearing the same superscripts are significantly different at: small letters – P≤0.05; capitals – P≤0.01.
*P≤0.05; **P≤0.01; ns – non-significant.

the intensive fattening system. In contrast, Kalinowska *et al*. [1997] while studying crossbreds of WI females × B bucks, found an increase in the share of the muscle tissue and a decrease in fat content of carcasses of crossbreds compared to purebred WI kids.The latter results, however, pertained to much heavier carcasses of older kids which were less intensively fattened than in the present study.

The pH values for LD muscle 45 min and 24 h post-slaughter (Tab. 5) indicate a proper course of glycolysis and are similar to those reported by Kędzior *et al*. [1997], Dhanda *et al*. [1999] and Marichal *et al*. [2003]. In the present study and in that by Dhanda *et al*. [1999], both conducted on Boer goat crossbreds, similar levels of water loss were found during thermal processing. In this study and in that by Kędzior *et al*. [1997] a lower level of water-holding capacity and a higher content of intramuscular fat were recorded in crossbreds than in WI kids. This confirms earlier observations by Babiker *et al*. [1990] that the water-holding capacity of meat is affected by intramuscular fat content. Protein content of meat was found similar in all four groups of kids (Tab. 5). In earlier studies, in which apart from the effect of genotype the effect of live weight and slaughter age were considered [Kędzior *et al*. 1997, Dhanda *et al*. 1999, Marichal *et al*. 2003] protein content of kid meat was similar to that reported here in Table 5.

Table 6. Least squares means (LSM) and their standard errors (SE) for results of sensory evaluation of *longissimus dorsi* meat (points) in kids

Indicator		Kid genotype				
		White Improved (n=18)	¼ Boer ¾ White Improved (n=18)	½ Boer ½ White Improved (n=18)	¾ Boer ¼ White Improved (n=18)	Effect of genotype
Taste	LSM	9.1	9.4	9.6	9.6	ns
	SE	0.4	0.5	0.6	0.5	
Aroma	LSM	9.3	9.5	9.5	9.5	ns
	SE	0.5	0.6	0.5	0.5	
Tenderness	LSM	8.2	8.9	9.3	9.3	*
	SE	0.4^{ab}	0.6	0.5^{b}	0.4^{a}	
Juiciness	LSM	8.1	8.8	9.4	9.5	*
	SE	0.4^{ab}	0.5	0.4^{b}	0.4^{a}	

$^{aA...}$Means within rows bearing the same superscripts are significantly different at P≤0.05.
*P≤0.05; ns – non-significant.

Assessment of sensory attributes indicates good cooking value of meat of crossbreds (Tab. 6) and thus confirms the results presented in earlier reports [Kędzior *et al*. 1997, Dhanda *et al*. 1999, Tshabalala *et al*. 2003]. Only lower meat tenderness and juiciness in WI compared to 1/2B1/2WI and 3/4B1/4WI kids may result from a considerably higher intramuscular fat content of meat in these kids.

Basing upon the results presented here it can be stated that Boer sires improve carcass quality and meat value of their crossbred male progeny out of White Improved females and that way they can increase profitability of goat keeping.

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Wartość rzeźna, jakość tuszy i charakterystyka mięsa koziołków mieszańców rasy białej uszlachetnionej z rasą burską

S t r e s z c z e n i e

Badaniami objęto grupę koziołków rasy białej uszlachetnionej (*White Improved* – WI) i trzy grupy mieszańców tej rasy z rasą burską (*Boer* – B) o udziale 25, 50 i 75% genów B w genotypie (1/4B3/4WI, 1/2B1/2WI i 3/4B/1/4WI). Każda z czterech grup liczyła 18 zwierząt. Do uzyskania przez koziołki masy ciała 20 kg utrzymywano je przy matkach, zapewniając możliwość nieograniczonego ssania, a od 14 dnia życia swobodny dostęp do paszy stałej.

Mieszańce z 25, 50 i 75% udziałem rasy B w genotypie uzyskały założoną masę ubojową odpowiednio o 8, 19 i 23 dni wcześniej niż koziołki WI (95 dni). Wyższa była także ich wydajność rzeźna, a tusze pokryte były grubszą warstwą tłuszczu na żebrach i nad mięśniem LD oraz wykazywały mniejszy ubytek masy po schłodzeniu. Udział (%) tkanki mięśniowej w tuszach mieszańców i koziołków białych uszlachetnionych był podobny. Natomiast wraz z rosnącym w genotypie mieszańców udziałem rasy burskiej zwiększał się udział tłuszczu w tuszy, a malał udział kości. Stwierdzono niewielkie różnice w zawartości suchej masy i białka ogólnego oraz w pH45 i pH24 w mięśniu LD między mieszańcami a koziołkami białymi uszlachetnionymi. Mięso mieszańców z 50 i 75% udziałem rasy burskiej zawierało więcej tłuszczu śródmięśniowego oraz wykazywało mniejszy wyciek termiczny i mniejszą wodochłonność niż mięso czystorasowych koziołków białych uszlachetnionych. Ocena sensoryczna mięsa koziołków czystorasowych wykazała jego mniejszą kruchość i soczystość niż mięsa koziołków pozostałych grup.