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Carcass and meat quality of Friesian, Piemontese x Friesian and Limousin x Friesian young bulls under intensive beef production system in Turkey

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ABSTRACT

Carcass and meat quality of Friesian (F), Piemontese x Friesian (PixF) and Limousin x Friesian (LixF) young bulls, housed individually on tied stalls and fattened intensively from 180 to 460 days of age, were evaluated. PixF and LixF gave the higher yield, more muscular and leaner carcasses than F. The meat production was higher in the crosses. Mean warm carcass yield, conformation and fatness scores for F, PixF, LixF were 57.21, 61.05, 60.09 % ($P<0.001$); Ro, U-, U- and 3+, 2o, 2- ($P<0.05$), respectively. No significant differences were found for carcass measurements except carcass length, and for dissections weights except rump and chuck. For F, PixF, LixF, mean *M. longissimus dorsi* area was 76.10, 101.15, 91.88 cm^2 , respectively ($P<0.01$). There were no differences among F with PixF and LixF for muscle pH, and meat colour except tone. Meat colour tone at 24 h in LixF (53.79) was significantly higher than in F (49.76) and PixF (49.52) ($P<0.05$). Water holding capacity was lower in PixF than in F and LixF. Cook yield was higher in PixF than in F and LixF. Mean shear force for LixF was lower (14.87 kg) than that of F (18.66 kg) and of PixF (18.29 kg). It is concluded that carcass and meat quality traits of PixF and LixF young bulls were superior to those of F young bulls under intensive beef production system in Turkey.

KEY WORDS: carcass quality, meat quality, crossbreeding, intensive fattening, Friesian, Limousin x Friesian, Piemontese x Friesian

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INTRODUCTION

Friesian is a common European breed and has been spread in all regions of Turkey. Previously, it's dairy and beef capacity met the expectations of breeders. Also this breed showed good enough adaptation to Turkish conditions. But, nowadays, meat industry in Turkey needs new cattle genotypes for high meat production with better carcass and meat quality to meet consumer demand under intensive feeding condition. For this reason, crossing Friesian dairy cows with sire of beef breeds has been considered intensively by meat producer and breeders. Over a number of years, in several European Countries, numerous studies have been conducted to evaluate the progeny of beef breeds from dairy breeds cows for beef production. As a matter of fact, high percent of dairy breeds in France, Denmark, Ireland and England have been crossing with beef sire (Menissier et al., 1982). The rate of crossing of dairy breeds with beef sires has been increasing in Netherlands (Anonymus, 1989). Considerable studies have been carried out to improve growth performance of dairy breeds using beef sires under Turkish conditions. However, although genetic improvement programme that conducted in the European Countries prefers Piemontese and Limousin breeds because these breeds have good capacity of beef production (McGuirk et al., 1998), there was no published information on the carcass and meat quality of Piemontese x Friesian and Limousin x Friesian under intensive Turkish beef production systems.

The objective of this study was to evaluate carcass and meat quality of Piemontese x Friesian, and Limousine x Friesian young bulls versus Friesian young bulls under intensive beef production system in Turkey.

MATERIAL AND METHODS

Experimental design

The oestrous of Friesian cows, of the same age, was synchronized and these cows were artificially inseminated randomly with semen obtained from one Friesian, Piemontese and Limousin bull. Calving occurred within 30 days. A total of 21 male calves consisting of 7 F, 7 PixF and 7 LixF were used in the present study. Male calves were individually penned and weaned at the age of 60 days. Then, they were reared in genotype groups from 60 to 180 days of age under uniform management. After that they were moved to individual tied stalls for a intensive fattening period from 180 to 460 days.

Animal maintenance and nutrition

All animals were reared according to an intensive system under the same environmental condition. The intensive fattening period was 280 days. All animals were fed individually with a fixed amount of wheat straw (1 kg/day) as a forage source for beef cattle in Turkey and increasing amounts of concentrate from average 5 to 9 kg/day during fattening period to meet the increasing energy and protein requirements according to NRC (1984).

Measurements, analyses and calculation

During the trial, all animals were individually weighed every 28 days throughout the experiment. They were also weighed at the beginning of the experiment and prior to slaughter. The quantities of feed offered were recorded daily throughout the experiment. Proximate analysis of concentrate and straw were made according to the German system (Naumann and Bassler, 1993). Chemical composition of concentrate and straw are given in Table 1.

TABLE 1

Chemical composition of concentrate and wheat straw (as feed)

Nutrient, %	Concentrate	Wheat straw
Dry matter	90.74	91.74
Organic matter	83.37	82.44
Crude protein	14.89	5.95
Ether extract	2.25	1.22
Crude fibre	5.21	30.67
Nitrogen free extractives	61.02	44.60
Ash	7.37	9.30
Metabolizable energy, ME, kcal/kg	2655	1512

All animals were slaughtered at 460 days of age. The animals were weighed on the morning of slaughter at the commercial abattoir after 12 h fasting. Water was freely available throughout the fasting period except during transportation. The animals were transported within 45 min to abattoir. Slaughter occurred according to industrial routines used in Turkey. The hide, head and shanks were removed and their weights recorded. Femur length, femur circumference was measured from left side of the carcass. The body fat depots were removed, the weights of the non-carcass parts (tongue, lungs and trachea, liver, hearth, spleen) were also recorded. The carcass was halved, and the sides, including the kidney knob, testicles and the channel fat were weighed to determine the hot carcass weight. The warm carcass was cooled for 24 h at 2ºC and was reweighed. Left side of the carcass was classified for conformation (scale from S = super (1) to P

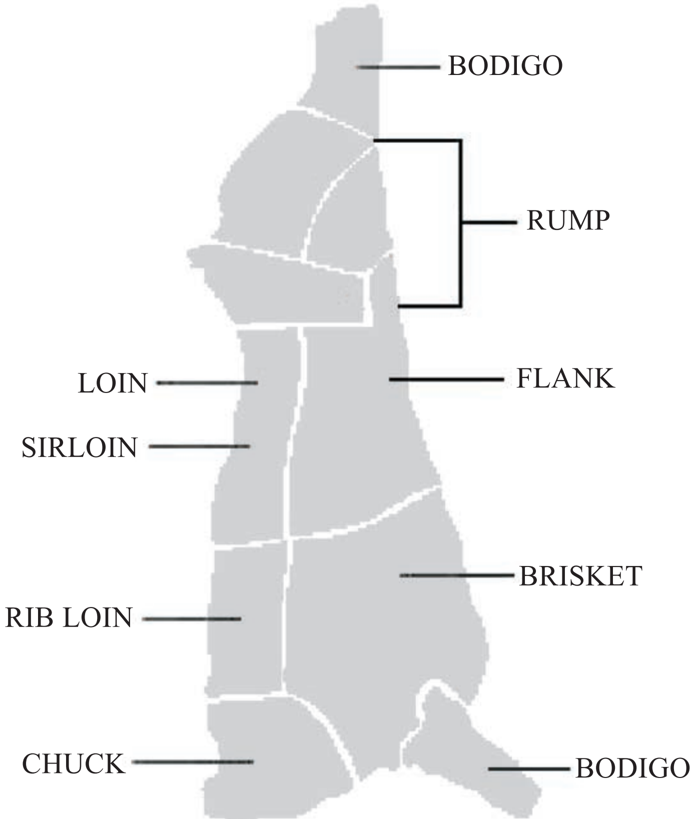

Figure 1. Anatomical cuts of side

= poor (6)) and fatness (scale from 1 = none or low fat cover to 5 = entire carcass covered with fat) according to the visual scores in the SEUROP system (EEC, 1991). The six classes for conformation and five classes for fatness were divided into three subclasses: +, o or –. Carcass length, carcass depth, carcass width, leg length, leg width, leg perimeter, *mld* length were measured. Ossification scores from first vertebra and sternum was recorded according to Roy et al. (1970). At 24 h post-mortem, muscle pH of the *M. longissimus dorsi* was measured directly on the 13th rib using a FC200 electrode attached to a portable pH meter (Hanna 8314). The pH meter was calibrated with Riedel-de Haën pH 4 and pH 7 standard solutions. The electrode was probed into carcass at a depth of 2.5 cm and three pH readings were taken. The chilled carcasses were ribbed between the 12th and 13th ribs. The forequarter and hindquarter from the left side of the carcass were dissected into primal cuts (Figure 1) and weighed. Kidneys, testicles and the channel fat were weighed. A 3 cm thick steak was removed from the anterior part of the loin eye at the 13th rib and placed in a styrofoam tray over wrapped with oxygen-permeable film and was stored 24 h at 4°C. Colour was measured using Minolta CM 508d spectrocolorimeter after placing lens on the meat surface, it was turned through 0, 45, 90º (clockwise) and readings were averaged later. L* (lightness), a* (red colour coordinate) b* (yellow colour coordinate) were measured using D65 Illumination, and (10º) Standart Observer (CIE, 1986). C* (chroma) defined as the square root of $a^{*2} + b^{*2}$, h* (hue) defined as tan-1 (b/a). The water holding capacity of meat was assessed by filter paper test after a 7 day storage at 4°C. Cooking loss was assessed by placing weighed meat slices of approximately 3 cm thickness in polythene bags and heating them in a water bath at 75ºC for 20 min until ultimate temperature was reached to 70ºC. Then, the samples were weighed and cooking loss was calculated as a percentage of the weight of the original sample after cooling to room temperature. Five core samples, 1 cm in diameter and 35-40 mm long were removed parallel to muscle fibres from each slices to determine shear force. Shear force was measured using Instron Universal Testing Machine, fitted with Warner Bratzler (WB) shear attachment. Full-scale load was set at 50 kg and chart drive and crosshead speeds were 200 mm/min.

General linear model was used to identify source of variation associated with genotype in SPSS V8 (1997). Initial weight as a covariate was not included in the model for carcass quality traits and ultimate pH (pH 24 h after slaughter) as a covariate was not included in the model for colorimetric parameters, water holding capacity, cook yield and shear force because they were found not to be significant. Significant differences between means with the respect to carcass and meat quality were detected using Scheffe test.

RESULTS

Growth parameters

Growth parameters are presented in Table 2. PixF calves had higher initial weights (220.3 kg) than F calves, whereas LixF calves had lower initial weights (195.3 kg) than Friesian calves (204.3 kg), ($P<0.05$). However, initial weight as covariate had not significant effect on final body weight and daily gain of body weight. Although, genotype were found not to be significant for growth parameters, PixF had the higher final body weight (518.9 kg) compared with F (500.9 kg) and LixF (487.6 kg). Mean daily weight gain for the PixF, F and LixF was 1066.3, 1059.2 and 1043.9 g, respectively.

TABLE 2

Ls means and standard error for growth parameters, carcass quality traits and carcass measurements of left side carcass of F, PixF and LixF young bulls

Parameter	Breed				Breed
	F	Pi x F	Li x F	SEM	Sign
Initial weight, kg	204.29[b]	220.29[a]	195.29[b]	4.32	***
Final body weight, kg	500.86	518.86	487.57	12.35	ns
Daily gain, g	1059.18	1066.33	1043.88	49.35	ns
Warm carcass yield, %	57.21[b]	61.05[a]	60.09[a]	0.59	***
Cold carcass yield, %	56.49[b]	60.21[a]	59.39[a]	0.59	***
Conformation (SEUROP) (1-18 score)	Ro 7.86[b]	U- 10.29[a]	U- 9.57[a]	0.39	***
Fatness (1-5) (1-15 score)	3+ 8.86[b]	2o 11.29[a]	2- 9.86[a]	0.48	**
Carcass length , cm	139.21[a]	137.21[a]	132.86[b]	1.74	*
Carcass depth, cm	37.79	37.07	38.29	0.78	ns
Carcass width, cm	65.29	64.36	64.14	1.28	ns
Leg length, cm	85.00	84.64	84.07	0.92	ns
Leg width, cm	45.57	45.07	42.43	1.13	ns
Leg circumference, cm	117.64	116.36	114.43	1.45	ns
MLD length, cm	39.00	39.21	37.64	0.49	ns
Femur length, cm	35.29	34.79	35.57	0.47	ns
Femur circumference, cm	16.29	16.21	16.07	0.28	ns
Ossification (1st Vertb)	5.21	5.00	4.93	0.26	ns
Ossification (sternum)	2.14	1.57	1.43	0.22	ns

* P<0.05, **:P<0.01, ***P<0.001, n.s. non significance

[abc] means with different letters in the same row are significantly different (P<0.05)

Carcass quality

Mean carcass quality traits are shown in Tables 2 and 3. Significant differences were found in warm (P<0.01) and cold carcass yield (P<0.001) with differences in the carcass conformation (P<0.01) and fatness (P<0.05). Warm carcass yield was higher for beef crosses than for F, by about 6.7% for PixF and 5% for LixF.

Carcass conformation score was 31% for PixF and 22% for LixF superior to that for F while compared with F fat score was lower for PixF and LixF. F carcasses were more than one subclass fatter than the LixF carcasses (+3 vs -2) and two subclass fatter than the PixF carcasses (+3 vs 2). But, both crossbreeds were similar in conformation "U-" whereas F young bulls showed "Ro" conformation. As ossification score is a measure of the physiological maturity of the carcass, ossification score of first vertebra and sternum confirmed that F young bulls matured earlier than crosses at 460 days. Differences among genotypes for carcass measurements were found to be non-significant except carcass length.

TABLE 3

Ls means and standard error for dissection of left side carcass of F, PixF and LixF young bulls

Parameter	Breed				Breed
	F	Pi x F	Li x F	SEM	Sign
Warm left side carcass weight, kg	143.89	159.66	146.09	5.09	ns
Cold left side carcass weight, kg	142.00	157.51	144.86	5.04	ns
Hind quarter weight, kg	63.64	69.61	66.66	1.68	ns
Rump, kg	36.13[b]	40.96[a]	38.83[ab]	0.95	**
Flank, kg	6.66	5.87	6.04	0.47	ns
Loin, kg	1.96	2.06	1.91	0.09	ns
Sirloin, kg	2.56	2.97	2.67	0.20	ns
Fore quarter weight, kg	77.59	85.69	78.08	2.96	ns
Brisket, kg	20.54	23.20	21.19	1.05	ns
Chuck, kg	11.01[b]	15.20[a]	11.03[b]	0.67	***
Rib loin, kg	5.46	6.10	5.63	0.29	ns
Bodigo, kg	19.57	21.61	18.94	0.79	ns
MLD area, cm^2	76.10[b]	101.15[a]	91.88[a]	4.52	**
Fat, %	7.17	7.36	7.62	0.58	ns
Bone, %	18.44[a]	16.31[b]	16.26[b]	0.63	*

* P<0.05, ** P<0.01, *** P<0.001, n.s. non significance

[abc] means with different letters in the same row are significantly different (P<0.05)

F carcasses have longer carcasses than crosses significantly (P<0.05). Even though the other carcass measurements of Friesian particularly were higher than crosses, small differences were found among breed types for carcass measurements. In our study, there was a little difference between F, PixF and LixF young bulls in carcass measurements but there were obvious differences for carcass length among three genotypes.

At the commercial dissection, the meat production was higher in crosses than in Friesian. As shown in Table 2, the hind and forequarter weights were higher in PixF crosses compared with LixF and F. For F, PixF, LixF, mean hind quarter and forequarter, 63.64, 69.61, 66.66 kg and 77.59, 85.69, 78.08 kg, respectively, without differences statistically. There were significant increases in rump and chuck weight, mld area of F when beef sire were used (P<0.05). For F, PixF, LixF, mean rump, chuck weight, the area of the *M. longissimus dorsi,* were 36.13, 40.96, 38.83 kg, 11.01, 15.20, 11.03 kg, 76.10, 101.15, 91.88 cm^2, respectively. When compared during 460 day fattening period, there was no difference in fat percentage among breed types but bone percentage was significantly higher in F (18.44%) than in PixF (16.31%) and PixF (16.26%), (P<0.05). Compared with the Friesian young bulls, crosses had lower bone ratio in the present study.

Meat quality

Mean meat quality parameters are shown in Table 4. Muscle pH, colour parameters (L*, a*, b*, C*) and water holding capacity, cook yield and shear force did not differ significantly among genotypes. But significant differences were found for h* among meats of genotypes. At 24 h post mortem, mean muscle pH of the Friesians was 5.98 whereas the pH values of the LixF and PixF were 5.91 and 5.97. Also, the change was not of sufficient magnitude to results in dark, firm and dry meat (pH<6.1). Muscle pH value was slightly higher in F and LixF than in PixF.

LixF muscle was brighter (large L* values), less red (less positive a* value), more yellow (more positive b* value) as compared with values obtained for F and PixF muscle. The larger L* values observed for crosses muscles indicate an increase in the amount of light reflected from muscle surface, resulting in a brighter colour. Also the larger C* values for crosses muscles indicate an increase in the vividness of the meat. Besides, the tone of the LixF meat significantly different than the tone of the F and PixF meats (P<0.05). For F, PixF and LixF, mean colour tone 49.76, 49.52 and 53.79, respectively. Water holding capacity was particularly lower for PixF (25.39%) compared with F (22.85%) and LixF (22.19%), in other words, more water excluded from the muscle of PixF. Also, cook yield was higher for PixF meat (17.39%) compared with F (15.24%) and LixF meats (16.30%). LixF meat (14.87 kg) was more tender compared to F (18.66 kg) and PixF (18.29 kg) meat. Water holding capacity was also lower and cook yield was higher for LixF young bulls compared with PixF young bulls.

TABLE 4

Ls means and standard error for meat quality traits of F, PixF and LixF

	Breed				Breed
	F	PixF	LixF	SEM	Sign
Muscle pH at 24 h	5.98	5.91	5.97	0.09	ns
Lightness, L* at 24 h	34.94	35.37	36.33	0.93	ns
a* coordinate, a* at 24 h	5.64	6.05	5.62	0.66	ns
b* coordinate, b* at 24 h	6.62	7.11	7.61	0.73	ns
Chroma, sqrt (a^2+b^2) at 24 h	8.70	9.34	9.48	0.97	ns
Tone, $\tan^{-1}$ (b/a) at 24 h	49.76^b	49.52^b	53.79^a	1.10	*
Water holding capacity, %	22.71	25.57	22.14	1.99	ns
Cook yield, %	15.24	17.39	16.30	1.33	ns
Shear force, kg	18.66	18.29	14.87	1.75	ns

* P<0.05, n.s. non significance

[abc] means with different letters in the same row are significantly different (P<0.05)

DISCUSSION

The investigation was to determine the effect of genotype (PixF, LixF vs F) on carcass and meat quality under intensive fattening system in Turkey. It appeared that growth rate of PixF were higher than that of F and LixF young bulls but differences were not significant. Our findings are in agreement with the results of Menissier et al. (1982) who found that PixF young bulls had a higher growth rate than LixF young bulls. Likewise, Begström (1985) suggests that Piemontese breed matures at an earlier age than the Limousin breed (Hoving-Bolink et al., 1999). Besides, in this study PixF grew faster and reached a higher final body weight than F but differences were not significant. These results confirm the results of Weglarz et al. (1997) who found that final body weight averaged 421 and 432 kg, respectively for bulls of Polish Black-and-White (PBW) and PBW x Piemontese. The results of Litwińczuk and Litwińczuk (1998) and Hoving-Bolink et al. (1999) seem to be in contrast with our results and those of Weglarz et al. (1997). Hoving-Bolink et al. (1999) found that LixF both had higher final body weight (599 vs 580 kg) and daily gain (1042 vs 979 g/day) than PixF. Litwińczuk and Litwińczuk (1998) found similar final body weight for Polish BW (496 kg) and Polish BWxLi (494 kg) but these genotypes had higher final body weight than Polish BWxPi (479 kg). But, crosses had significantly higher daily weight gain than Polish BW (842 g), although similar daily weight gain was found for Polish BWxLi (908 g) and BWxPi (904 g).

Our study showed that the crosses had better the carcass and meat quality characteristics than F. The results obtained from this study on carcass yield is in agreement with results of Purchas et al. (1992) and Hrûska (1993). Most muscular, higher lean carcasses of PixF and LixF than Friesian young bulls were in agreement with previous findings (Szücs et al., 1992; Keane and Allen, 2002). It was reported that Piemontese cattle generally had excellent carcass quality traits and had less fat and more muscle than Limousin cattle (Menissier et al., 1982). A lower carcass fat score for Piemontese crosses than the other beef crosses has also been reported by Grundy et al. (2000). Keane and Allen (2002) also found that carcass fat score was significantly lower for PixF than that for F. Furthermore, Szücs et al. (1992) found a higher percentage of lean (74.5 vs 72.8) and lower percentage fat (11.0 vs 12.7) for LixF bulls compared with F bulls.

In the study a higher growth rate resulted in a higher carcass weight, a better conformation. Steen and Kilpatrick (1995) reported that Limousin x Friesian cattle produced carcasses which were significantly heavier and of better conformation than those produced by Friesians. Also, the significant increase in rump weight of Friesians when beef breed sire were used, are in agreement with previous findings (Kempster et al., 1982; Keane and Allen, 2002). Rib eye area of Friesian was increased when beef breed sire were used, are in agreement with previous findings (Weglarz et al., 1997; Litwińczuk and Litwińczuk, 1998).

Muscle pH value was higher for PixF. This may have caused by PixF young bulls having a less aggressive behaviour than F and LixF young bulls. Our findings on meat colour, water holding capacity, cook yield and shear force value among breed types are in disagreement with Having-Bolink et al. (1999). In this study, LixF young bulls had higher colour tone and more tender meat than PixF young bulls contrary to the results of Having-Bolink et al. (1999). Our findings are also confirmed several researcher (Renand, 1988; Destefanis et al., 1996) who suggest that muscle of hypertrophied provoke lower water holding capacity. The results on tenderness is in agreement with the results of Litwińczuk and Litwińczuk (1998) who found that FxLi had slightly more tender meat compared with Polish BW and Polish BWxPi.

CONCLUSIONS

The results of the present study indicate that carcass yield, conformation and fatness score, commercial cuts and meat colour tone of PixF and LixF was better than F under intensive beef production system in Turkey. It appears that there is an advantage in using PixF or LixF young bulls compared with F young bulls for meat production under intensive feeding particularly if we are considering the amount of meat and quality. Results showed that PixF and LixF young bulls had higher carcass weight, a better conformation but meat colour and tenderness were better for LixF young bulls during at 460 days of age under intensive beef production system in Turkey.

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STRESZCZENIE

Jakość tuszy i mięsa młodych buhajów rasy fryzyjskiej, piemontese x fryzyjska oraz limusin x fryzyjska opasanych systemem intensywnym stosowanym w Turcji

Oceniono jakość tuszy i mięsa młodych buchajów ras: fryzyjskiej (F), piemontese x fryzyjska (PixF) oraz limusin x fryzyjska (PixF), utrzymywanych indywidualnie na stanowiskach na uwięzi i opasanych intensywnie od 180 do 460 dnia życia.

Mieszańce (PixF i LixF) miały większą wydajność rzeźną, były lepiej umięśnione oraz miały mniej otłuszczoną tuszę, a produkcja mięsa była u nich większa niż u F. Wydajność rzeźna ciepła, ukształtowanie tuszy oraz wskaźnik otłuszczenia buhajów F, PixF oraz LixF były następujące: 57,21; 61,05 i 60,0% (P<0,001); Ro, U-, U- oraz 3 + , 2o i 2- (P<0,05), odpowiednio. Nie stwierdzono istotnych różnic w wymiarach tuszy, z wyjątkiem jej długości, oraz w masie wyrębów dysekcyjnych, z wyjątkiem części krzyżowej oraz karkowej. Średnia powierzchnia *M. longissimus dorsi* wynosiła u F, PixF i LixF 76,10; 101,15 i 91,88 cm^2, odpowiednio (P<0,01). Nie stwierdzono różnic pomiędzy fryzami a mieszańcami w pH mięśni i barwy mięsa, z wyjątkiem jej intensywności, zdolności wiązania wody, wydajności po ugotowaniu oraz wartości siły cięcia. Nasilenie barwy mięsa w 24 godzin u LixF (53,79) było istotnie większe (P<0,05) niż u F (49,76) i Pi x F (49,52). Zdolność wiązania wody była gorsza, a wydajność po ugotowaniu była wyższa u PixF niż u pozostałych ras. Średnia siła cięcia była niższa u LixF (14,87) niż u F (18,66 kg) i PixF (18,29 kg).

Na podstawie otrzymanych wyników stwierdzono, że cechy jakościowe tuszy i mięsa młodych buhajów mieszańców PixF i LixF były lepsze niż u F, przy intensywnym systemie opasu stosowanym w Turcji.