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Effects of porcine somatotropin on the chemical body composition and fat quality in growing-finishing pigs

Untersuchungen zum Einfluß von porcinem Somatropin auf die chemische Körperzusammensetzung von Mastschweinen

Summary Seventy eight growing-finishing pigs (male castrates and females) of the cross-breed Pietrain x (Large White x German Landrace) were used to investigate the effects of pST treatment on the chemical composition of the body, the growth of adipocytes, and the fatty acid profile of the backfat. Intramuscular injections (1 or 3 mg pST) were administered daily from an average weight of 65 kg up to slaughter. After pST treatment significant changes in all studied characteristics were observed in barrows, whereas the females exhibited very small responses. The pST caused an increase of water and protein contents and a simultaneous decrease of lipid content especially in body parts rich in fat. Furthermore, the proportion of unsaturated fatty acids increased and the fat cell diameter decreased in the backfat.

Zusammenfassung An 78 männlichen Kastraten und weiblichen Schweinen der Kreuzung Pietrain x (Deutsches Edelschwein x Deutsche Landrasse) wurden Untersuchungen zum Einfluß einer porcinen Somatotropin (pST)-Behandlung während des Wachstums auf die chemische Körperzusammensetzung der Tiere, das Adipozyten-Wachstum und das Fettsäure-Profil des Rückenspecks untersucht. Die intramuskulären Injektionen (1 oder 3 mg pST) wurden täglich ab durchschnittlich 65 kg Lebendgewicht bis zum Schlachten verabreicht. Nach der pST-Behandlung wurden bei den Kastraten in allen untersuchten Merkmalen signifikante Unterschiede festgestellt, während sich bei den weiblichen Tieren nur leichte Reaktionen zeigten. Das pST verursachte eine Zunahme des Wasser- und Proteingehaltes bei gleichzeitiger Reduzierung des Lipidgehaltes besonders in den fettreichen Körperteilen der Tiere. Im Rückenspeck war der Gehalt an ungesättigten Fettsäuren erhöht und der Fettzelldurchmesser erniedrigt.

Key words Body composition – fat – growth – somatotropin – pig

Schlüsselwörter Körperzusammensetzung – Fett – Wachstum – Somatotropin -Schwein

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Introduction

Porcine somatotropin (pST) treatment of growing-finishing pigs elicits dose-dependently marked reduction in lipid deposition and increase in protein deposition in carcass associated with improvements in the rate and efficiency of gain (3-5). Alterations in carcass composition are due to both increased lipolytic rates and decreased lipid synthesis associated with enhanced protein synthesis (9). In a previous study on barrows with a low inherent capacity for protein deposition (East German Landrace) it was shown that the nutrient repartitioning occurs disproportionally within the individual body components (7). Body components with initially higher lipid content were mostly exposed to stronger changes in

chemical composition than body parts with lower lipid content. The objective of the present study was to confirm and to extend our earlier observations with regard to different nutrient repartitioning by using genetically leaner pigs of different sex.

Material and methods

Seventy eight growing-finishing pigs of the genotype Pietrain x (German Landrace x Large White) were included into the experiment. The number of casfrated males and females was equal (39 castrated males, 39 females). The pigs were penned individually and fed a commercial diet containing 12.56 MJ metabolizable energy, 160 g crude protein, and 9 g lysine per kg dry matter. They were fed twice daily with free access to the feed. Water was available ad libitum. The pigs were divided randomly into three groups (group 1: without treatment = control; group 2: 1 mg pST */pig and day; group 3: 3 mg pST /pig and day). The pigs of the two experimental groups were treated with pST from 65 kg live weight on average up to slaughter. The somatotropin was injected intramuscularly. The pigs were slaughtered when they attained approximately 108 kg live weight. After slaughter all organs were weighed. The left side of the carcass was dissected into wholesale cuts. Each cut was completely separated into meat (incl. intermuscular and intramuscular adipose tissue), external adipose tissue (fat layer) and bones. For chemical analyses the carcass half was dissected into external adipose tissue, internal adipose tissue, breast/belly, head, neck, loin, tenderloin, shoulder, leg, feet, and edible internal organs. The contents of water, protein, lipid, and ash of these individual cuts were determined. Subsequently, the nutrient content of the whole carcass (incl. edible internal organs) was calculated. The chemical analyses were done according to methods described by Kuhn et al. (8). For fatty acid analysis the lipids of the backfat layer were extracted according Nürnberg et al. (11). Histological criteria of the backfat were studied on 10 µm sections of the two superficial layers which were obtained by biopsy. This technique was described by Rehfeldt et al. (12). The data were analysed by the least squares using the GLM procedure of SAS®. The influence of sex, pST treatment and their interaction was studied by using a model of analysis of covariance considering the slaughter weight as covariate.

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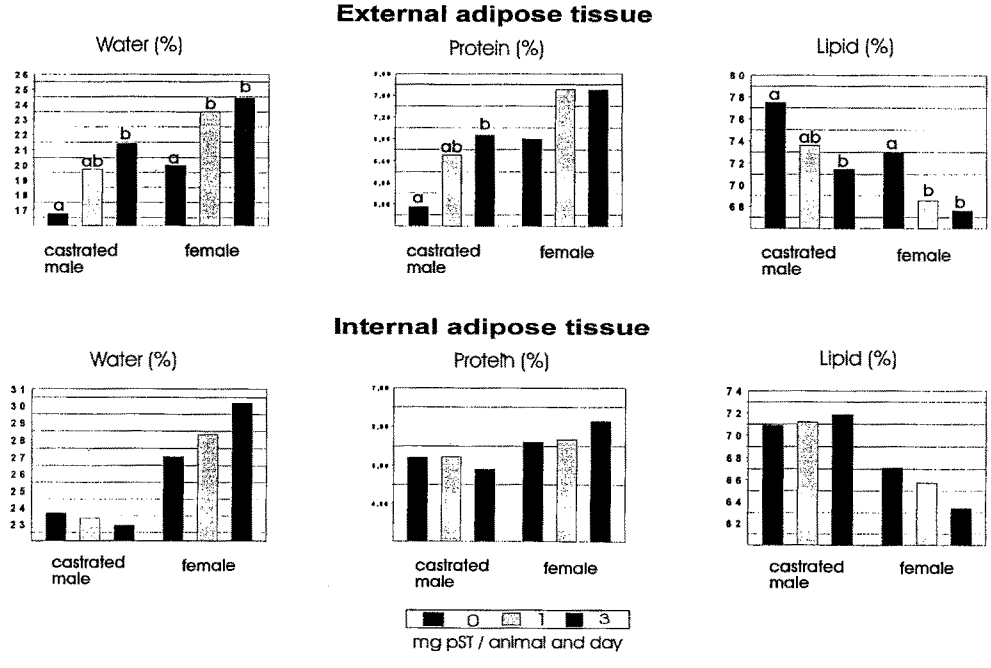

Fig. 1a Effect of pST administration on the chemical composition of the two carcass cuts external adipose tissue and internal adipose tissue

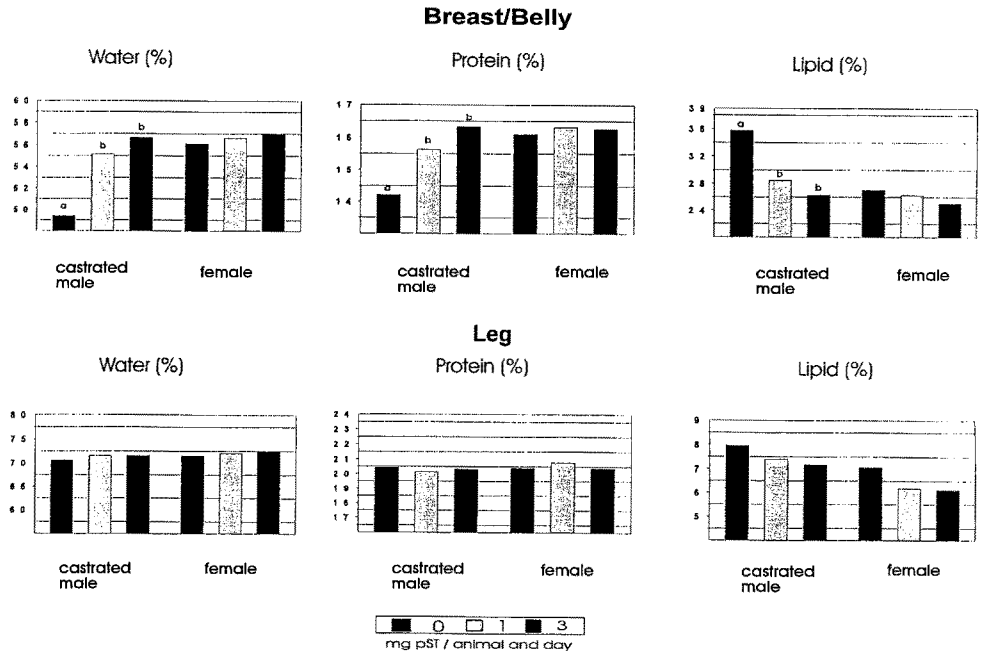

Fig. 1b Effect of pST administration on the chemical composition of the two carcass cuts breast/belly and leg

Results and discussion

The effect of sex and exogenous pST upon tissular and nutritional carcass composition in castrated males and females were investigated. Female pigs contained more meat and less fat in the carcass in comparison to castrated male pigs (Table 1). Chronic pST treatment improved the carcass composition dependent on sex. The meat percentage and the percentage of external adipose tissue were significantly influenced in castrated males but not in females. However, bone percentage was more strongly influenced in females than in castrated males. In summary, the effects of pST administration were lower in comparison to previous studies (7) in which pigs with lower lean meat content were used. The chemical body composition (whole carcass incl. edible internal organs) of castrated males was significantly altered by pST (Table 2) and was finally comparable with that of untreated females. The influence of the pST dose was not important. Generally, females showed a very slight or no reaction to pST. Different reactions of castrated males, females, and intact males on pST were also reported from other studies (1, 2, 6). Presumably, females are less responsive than castrated males to pST because of differences in the endocrine status.

Compared to other body components the external adipose tissue showed the strongest pST-induced changes (Fig. 1). The differences were significant for barrows and females (except protein content in females). Nevertheless, the effects were higher in barrows than in females. The water content increased by 28 % in barrows and by 22 % in females (group 3). The protein content was 24 % and 13 % higher, respectively. On the other hand, the lipid content decreased by 8 % in barrows and by 7 % in females.

Internal adipose tissue showed no significant changes in all chemical characteristics although it is a tissue with very high lipid content.

The breast/belly cut was significantly influenced by pST in barrows only. The lipid content was decreased by 24 % (group 3). This difference is higher than that for external adipose tissue of the respective group. The protein content was increased by 15 %.

The leg is a cut with high water and protein content and a low lipid content. The initial chemical composition of the leg is almost identical in barrows and females and could not be significantly changed by pST.

The decreased growth of backfat in response to pST administration was associated with slower fat cell growth (Fig. 2). However, the sex-treatmentinteraction is very clear. The differences in fat cell size between experimental groups and control were significant in barrows only. In barrows the fat cell diameters of both experimental groups were approximately 80 % of the control values. Presumably, pST acts on backfat by inhibiting the growth of visible fat cells as well as the lipid filling of 'empty fat cells' (12).

The pST induced decrease of lipid content in external adipose tissue was accompanied by changes in the fatty acid profiles (Fig. 2). Adipose tissue of pST treated pigs contained more polyunsaturated fatty acids (PUFA). Apparently the delayed fatty acid synthesis in adipocytes by pST reduced the incorporation of de novo synthesized fatty acids into triglycerides. Similar results have been reported previously by Mourot et al. (10).

Tab. 1 Effect of pST administration on carcass traits of pigs

		castrated male			female		
		mg pST / animal and day					
		0	1	3	0	1	3
n		15	11	13	13	13	13
Carcass weight	kg	87.30	88.20	85.75	86.82	86.71	86.18
Meat	%	63.54[a]	67.95[b]	67.86[b]	67.58	69.23	68.44
Extern. adip. tissue	%	17.78[a]	13.39[b]	13.36[b]	13.93	12.13	12.15
Bones	%	11.62	11.72	11.76	11.82[a]	12.02[ab]	12.42[b]

Tab. 2 Effect of pST administration on the chemical whole carcass composition of pigs

		castrated male			female		
		mg pST / animal and day					
		0	1	3	0	1	3
n		15	11	13	13	13	13
Water	%	56.39[a]	60.72[b]	60.91[b]	60.68	62.54	62.86
Protein	%	16.07[a]	17.05[b]	17.14[b]	17.39	17.83	17.73
Lipid	%	26.74[a]	21.43[b]	21.13[b]	21.10	18.76	18.56
Ash	%	0.79	0.81	0.82	0.86	0.87	0.86

Conclusion

The administration of pST induced a nutrient repartitioning in most of the body components directed to higher water and protein content and to lower lipid content. The effect of pST treatment was lower than the effect of sex in most of the investigated carcass characteristics possibly caused by the high endogenous potential for protein deposition of the pigs. Accordingly, a pST dose effect was not apparent. Females showed a lower response to pST than barrows presumably caused by their higher inherent capacity for protein deposition. Body components with higher lipid content such as backfat, breast/belly, and head were mostly exposed to stronger changes in chemical composition. The decrease of carcass lipid content was accompanied by an increase in the proportion of unsaturated fatty acids and a reduction of fat cell size. The results strengthen the hypothesis that a physiological limit in nutrient repartitioning within the carcass exists.

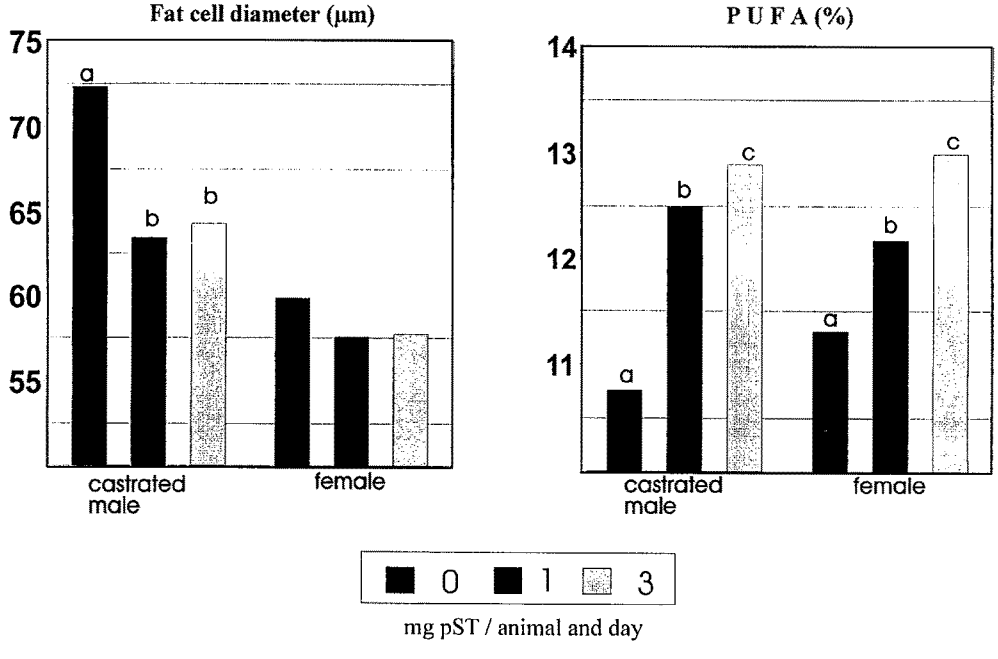

Fig. 2 Effect of pST administration on adipocyte size and proportion of polyunsaturated fatty acids (PUFA) in backfat of pigs

References

1. Bonneau M, Lefaucheur L, Mourot J (1989) Influence de l'administration de somatotrope porcine (st) sur les performances de croissance, la composition corporelle et la qualité des viandes. J Rec Porc France 21:31
2. Campbell RJ, Johnson R, King H, Taverner MR (1990) Effects of gender and genotype on the response of growing pigs to exogenous administration of porcine growth hormone. J Anim Sci 68:2674
3. Ender K, Rehfeldt Ch (1993) Effects of porcine somatotropin (pST). Meat Focus 11:501-505
4. Etherton TD, Wiggins JP, Evock CM, Chung CS, Rebhun JF, Walton PE, Steele NC (1987) Stimulation of pig growth performance by porcine growth hormone: Determination of the dose-response relationship. J Anim Sci 64:433
5. Evock-Clover CM, Steele NC, Caperna TJ, Solomon MB (1992) Effects of frequency of recombinant porcine somatotropin administration on growth performance, tissue accretion rates, and hormone and metabolite concentrations in pigs. J Anim Sci 70:3709
6. Kanis E, Nieuwhof GJ, de Greef KH, van der Hel W, Verstegen MWA, Huisman J, van der Wal P (1990) Effect of recombinant porcine somatotropin on growth and carcass quality in growing pigs: interactions with genotype, gender and slaughter weight. J Anim Sci 68:1193
7. Kuhn G, Ender K, Nürnberg K (1994) Der Einfluß von recombinantem porcinem Somatotropin (rpST) auf die chemische Zusammensetzung des verzehrbaren Gesamtkörpers und einzelner Körperfraktionen beim Schwein. Arch Tierz 37:623
8. Kuhn G, Ender K, Nürnberg K, Küchenmeister U, Hackl W (1995) Zur Körperzusammensetzung von Schweinen unter dem Einfluß des Einsatzes von recombinantem porcinem Somatotropin (rpST) und des Geschlechts. Arch Tierz 38:417
9. Mikel WB, Althen TG, Rogers RW, Moore AB, Miller HW, Miller LF (1993) Effects of exogenous porcine somatotropin on the carcass composition hormonal and metabolic profiles, lipogenic capacity, and binding of insulin to erythrocyte receptors of fast – versus slow-growing swine. J Anim Sci 71:1786
10. Mourot J, Bonneau M, Charlotin P, Lefaucheur L (1992) Effects of exogenous porcine somatotropin (pST) administration on pork meat quality. Meat Sci 31:219
11. Nürnberg K, Kuhn G, Nürnberg G, Rehfeldt Ch, Ender K (1995) Effect of porcine somatotropin (pST) on body composition meat quality and characteristics of backfat in genetically different pigs. Fat Sci Technol 97:153
12. Rehfeldt Ch, Ender K, Nürnberg K, Hackl W (1996) Cellular aspects of the repartitioning process induced by somatotropin in pigs up to 150 kg live weight in relation to growth and carcass characteristics. Arch Tierz 39:169