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EFFECTS OF PHYSICAL TRAINING ON THE MUSCLE FATTY ACID PROFILE OF MEAT TYPE RABBITS

DJELOVANJE FIZIČKOG VJEŽBANJA NA PROFIL MASNIH KISELINA U MESNATOM TIPU KUNIĆA

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Original scientific paper - Izvorni znanstveni članak
UDC: 636.9.:636.088.
Received - Primljeno: 18 may-svibanj 2002.

ABSTRACT

The present study was designed to investigate, whether meat type rabbits are able to perform treadmill running as a daily routine exercise, and if so, does the exercise induce specific proportional changes in the muscle fatty acid composition of the animals.

After a four week training period eight week old rabbits were slaughtered, the total activity of plasma lactate dehydrogenase was measured, showing a significant difference between the exercised and control groups (429±126 IU/1 vs. 639±203 IU/1). Furthermore the fatty acid composition of m. longissimus dorsi (MLD) and m. vastus lateralis (MVL) was determined by means of gas chromatography. Exercise increased the proportions of oleic acid (C18:1 n-9) in both longissimus dorsi and vastus lateralis muscles, compared to the control group. The level of stearic (C18:0) and arachidonic (C20:4 n-6) acids significantly decreased in the vastus lateralis muscle after exercise. Changes in the fatty acid profile resulting from the physically loaded condition were of identical tendency in both muscles, adding that MVL might have been exposed to the exercise more intensively; alterations there occured in a more pronounced manner. Based on the suggestion that the composition of membrane structure was also affected, these alterartions may have important consequences on meat quality.

Key words: rabbits, fatty acid profile, physical training, skeletal muscle

INTRODUCTION

Exercise is a widely applied method to follow metabolic responses. There are effects of exercise on the muscle metabolism, which in turn leads to compositional changes of muscle tissue. In the background of these changes the mobilization and the utilization of the fats may stand.

There are data in the literature regarding training induced changes in humans (Helge et al.,

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2001; Brouns et al., 1998), dogs, goats (McClelland et al., 1995) and rabbits (Frimen et al., 1998, Meng et al., 1990), but the changes of the muscles' fatty acid profile have not been much investigated. Although Helge et al. (2001) and Andresson et al. (1998) detected changes in human muscles in phospholipid fatty acid composition and Helge et al. (1999) in rats, no such investigation was performed on rabbits. In which way and extent fatty acid composition of rabbit muscles can be influenced has also been studied.

Based on these facts our experiment was performed to investigate, whether the substrates used during treadmill exercise of rabbits also involved middle and long chain fatty acids, and if so, which ones were affected by the moderate level of physical load in rabbits. From this aspect two muscles were chosen to analyse which were supposed to be involved in the specific exercise bout of rabbit; m. longissimus dorsi (m.l.d.) and m. vastus lateralis (m.v.l.).

MATERIALS AND METHODS

Pannon white rabbits were kept in a closed building in cages, and fed ad libitum a commercial pelleted diet (DE 10.3 MJ/kg, crude protein 16%, crude fat 3.4%, crude fibre 15.5%). At the age of four weeks two groups of 6-6 individuals were selected in a randomized manner; first was not treated and the second was exposed to treadmill running two times daily, until exhaustion, during the whole trial period. Training was continued between the 4th and 8th weeks of age in the exercised group and after the 8th week animals were slaughtered.

Muscle samples were taken from the left m. longissimus dorsi (m.l.d.) (always from the same location, i.e. from the 2nd to the 3rd lumbal vertebrae) and m. vastus lateralis (m.v.l.). Samples were homogenized with chloroform: methanol (2: 1) and the fat content was extracted. Prior to gas chromatography fatty acids were methyl-esterified and measuring was carried out using qualitative fatty acid standards. Results were always given in percentage of total fatty acids. Statistical analysis was carried out with independent samples T-test, at the significance level of 0.05, using SPSS 10 for Windows (1999). The trial with the parameters above was carried out in two repetitions.

RESULTS AND DISCUSSION

The exercise procedure of rabbits was carried out two times a day and the endurance and length did not show changes during the investigation; rabbits reached approximately a length of 0.6-0.8 km a day.

In both groups body weight gain and daily feed intake were monitored and no differences were found between groups in the production traits. Resulting from the homogeneity of the feed the daily energy intake can be handled as identical in the treated and control groups.

To follow effects of exercise total activity of lactate dehydrogenase was measured in both groups, at the end of the trial. Mean±SD for exercised and control rabbits were 429±126 IU/1 and 639±203 IU/1, respectively, and were found to be significantly different ($P<0.028$).

Results may be attributed to the regular moderate level aerobic exercise.

Data from the fatty acid analysis are shown in Table 1.

In case of m.l.d. an increasing tendency was observed in palmitic acid (C16:0) proportion, which did not reach significance. Results are in accordance with the finding of McClelland et al. (1995), who observed a higher palmitic acid mobilization during aerobic exercise. The elevated plasma concentration of C16:0 in a non-esterified form indicates a higher turnover of palmitic acid, also observed in our trial.

The proportion of stearic acid (C18:0) in m.l.d. was also affected by the exercise, but the decrease was only of borderline significance ($P<0.06$).

Table 1. Fatty acid composition of the trained and control rabbits m.l.d. and m.v.l.
Tablica 1. Sastav masnih kiselina mišića l.d. i v. l. kunića koji su vježbani i kontrolirani

Sample - Primjer		C14:0	C15:0	C16:0	C16:1(n-7)	C17:0	C18:0	C18:l(n-9)	C18:2(n-6)	C18:3(n-3)	C20:4(n-6)
m.l.d. Trained	mean srednji	1,80	0,41	27,32	2,50	0,43	7,85	21,75[a]	23,97	2,47	5,36
	SD	0,39	0,06	0,82	0,81	0,04	0,51	1,82	1,24	0,49	1,10
m.l.d. Control	mean srednji	1,66	0,45	26,97	2,20	0,59	8,38	20,05[b]	25,08	2,50	5,86
	SD	0,23	0,11	0,78	0,39	0,13	1,04	0,49	1,13	0,68	0,93
m.v.l. Trained	mean srednji	1,45	0,46	26,84	2,31	0,49	8,41[a]	19,60[a]	27,61	2,20	5,73[a]
	SD	0,25	0,05	1,47	0,47	0,06	0,71	1,23	1,85	0,35	0,90
m.v.l. Control	mean srednji	1,30	0,48	25,97	2,03	0,57	9,49[b]	16,83[b]	28,19	2,12	7,13[b]
	SD	0,24	0,04	1,35	0,50	0,05	1,71	1,47	1,04	0,26	0,77

Significance of differences: a, b: $P < 0.05$

The oleic acid (C18:1 n-9) proportion increased and the change was found to be significant. Oleic acid may be an indicator when analyzing exercise induced alterations in the muscle fatty acid profile. Andersson et al. (1998) found an elevation of this fatty acid in the muscle phospholipids due to exercise. McClelland et al. (1995) determined oleic acid as one of the highest contribution in plasma non-esterified fatty acids after exercise. From that viewpoint, its higher proportion in muscle fatty acid profile suggests an active oleic acid turnover during muscle exercise. In the authors opinion further investigations are needed to clarify, in what extent plasma FFA-s contributed in this treadmill exercise to the fatty acid utilization, because the fat mobilization from the adipose tissue fat depots is of a relatively low level in moderate exercise. It might be also of interest, that the somewhat lower proportion of stearic acid was paired with a higher oleic acid proportion, for these two are strongly related in synthetic biochemical pathways.

In poly-unsaturated fatty acids neither linoleic acid (C18:2 n-6), nor linolenic (C18:3 n-3) acid showed significant changes in the rabbits' m.l.d compared to the control values. Arachidonic acid (C20:4 n-6) proportion showed a decrease, but no significant difference could be proven.

The findingsIn m.v.l. were supposed to be similar to those of the m.l.d.; differences were expected with regard to the same fatty acids, but with pronounced alterations, because m.v.l. might be loaded in the exercise bout more intensively. The hypothesis was partly based on the fact that exercise induced changes in the fatty acid profile were published to occur irrespective of the fiber type distribution (Andersson et al., 2000) and which is more important, independently of dietary fatty acid composition (Helge et al., 1999).

An important but insignificant increase was measured in the palmitic acid proportion, similar to that in m.l.d.; the same was true for palmitoleic acid. Stearic acid was significantly lower and oleic acid was proved elevated (see Table 1.). The elevation of oleic acid might be of importance; this fatty acid may indicate training induced changes of the muscle fatty acid profile.

The linoleic acid proportion showed a decrease in the exercised group. Changes in linolenic acid occurred according to the authors' expectations: only a mild elevation was detected. In case of arachidonic acid the decrease was bigger than in m.l.d. and reached the significance level, possibly due to the somewhat higher load level of this muscle.

CONCLUSION

Summarized, the effects of medium level physical load could be effectively detected in the meat type rabbits' muscle fatty acid profile after a training period of four weeks. The relatively slight changes may be partly explained by the muscles' fiber type distribution, as both can be classified as fast muscles with a relatively high glycolytic capacity and lower fatty acid utilization. Therefore the investigation of a red muscle of the hind leg may be reassuring. In the authors' further investigations it has also to be clarified, in what extent triglycérides and phospholipids are affected in a treadmill exercise, as the changes of the phospholipids strongly influence the membrane properties, which in turn leads to the alterations of the meat quality.

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SAŽETAK

Cilj ovog rada bio je istražiti mogu li kunići mesnatog tipa izvesti trčanje na kotaču kao dnevnu rutinsku vježbu te ako mogu, potiče li vježba posebne razmjerne promjene u sastavu mišićnih masnih kiselina u životinja.

Nakon četiri tjedna vježbanja kunići su u dobi od osam tjedana ubijeni, izmjerena aktivnost laktata dehidrogenaze plazme koja je pokazala značajnu razliku između skupine koja je vježbala i kontrolne (429±126 IU/1 prema 639±203 IU/1). Osim toga, određen je sastav masne kiseline mišića longissimus dorsi (MLD) i m. vastus lateralis (MVL) pomoću plinske kromatografije. Vježbanje je povećalo omjere oleične kiseline (C18:1 n-9) u mišićima longissimus dorsi i vastus lateralis u usporedbi s kontrolnom skupinom. Razina stearične (C18:0) i arahidonične (C20:4 n-6)/ kiseline značajno se smanjila u mišiću vastus lateralis poslije vježbanja. Promjene profila masne kiseline kao rezultat fizički opterećenog stanja imale su istu tendenciju u oba mišića, uz to da je MVL možda bio izložen intenzivnijem vježbanju; promjene su tamo bile intenzivnije. Na temelju prijedloga da je sastav strukture membrane također zahvaćen ove promjene mogu imati važne posljedice na kakvoću mesa.

Ključne riječi: kunići, profil masnih kiselina, fizičko vježbanje, mišić kralježnice