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Anti-fatigue effect of beef

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BACKGROUND

Among various foods, meat provides not only nutritional and sensory functionality, but provides an additional 3rd regulatory function as well. Beef, in particular, can be expected to have an influence on recovery from fatigue as well as in imparting energy and vitality. We decided to examine the efficacy of beef in mice rations in preventing fatigue (Wakamatsu et. al., 1996).

OBJECTIVES

In this study, in order to examine the effects of an effective composition of beef, a specimen which had undergone freeze-drying and fat removal processing and a protein purified from beef were used as the protein source for rations given to the mice and changes in metabolic parameters before and after free swimming were evaluated.

METHODS

Animals and rations: 8 week old ICR male mice were raised for 7 weeks on a ration containing 20% protein and 6% fat (22℃ room temperature, 60% humidity, 12 hr lighting). Beef and milk casein were used for the protein component, and beef tallow (BT) and corn oil (CO) were used for the fat component. Mice were grouped as follows: freeze-dried beef and BT (FD); lipid-extracted beef and CO (LE); protein purified from beef and CO (PP); casein and CO (20C, control). Mice were allowed free access to drinking water throughout the experiment period.

Measurement of free swimming periods: A weight weighing 5% of the mouse's body weight was wound around the base of its tail and the mouse was allowed to swim freely in 34℃ water. When a mouse's head remained below water for a period of 7 seconds or more, the mouse was judged to have become fatigued and the period of time from immersion to this point was recorded as the free swimming time.

Biochemical evaluation: An auto-analyzer (EXPRESS Plus, CIBA-CORNING) was used to analzyze serum glucose (GLU), triglyceride (TG), lactic acid (LA), 3-hydroxybutyrate (3-HBA), total carnitine (t-CAR) and creatine kinase activity (CK) levels.

Statistical analysis: Results were given as means ± standard error, and were analyzed by one way ANOVA, significant differences were determined via Duncan's multiple-range test. A value of $P < 0.05$ was considered significant.

RESULTS AND DISCUSSION

In all test areas up through the completion of the experiment, all groups showed similar reductions in rations consumed with similar changes in body weight, with no significant differences were noted. The free swimming times of the mice which were fed FD, PP, and LE rations increased by 42%, 29%, and 10%, respectively, as compared to the 20C mice (Table 1). The extended free swimming times of the FD mice were as reported before. These results suggest that beef protein have an anti-fatigue effect.

Hepatic triglyceride levels in FD at the times prior to, after, and at 30 minutes after swimming were the highest, however, hepatic glycogen levels were the lowest (Table 2). Liver weights in relation to body weights were significantly high in FD prior to free swimming. It may be surmised that the correspondent increase in the liver weights evinced by FD was due to an increase in hepatic triglyceride levels. Serum glucose level was significantly reduced at 30 minutes after swimming in 20C, however, no similar reduction was observed in FD, LE or PP (Table 3). Serum lactic acid levels immediately after swimming were also lower than in 20C for the FD, LE and PP. Differences in 3-hydroxybutyrate, which serves as an indice for fatty acid metabolism, were not noted in any of the 4 groups. It may be posited from these results that beef affects the metabolism of glucose rather than that of fatty acids, possibly by activating the Cori Cycle.

CONCLUSIONS

A tendency for the prologation of free swimming times by 10-40% was observed in the FD, LE and PP groups as compared to 20C. Serum glucose levels in 20C at 30 minutes after swimming were lowered, however, in the 3 groups fed on the beef rations (FD, LE and PP), similar reductions were not observed. Serum lactic acid concentrations immediately after exercise were elevated in 20C, however, no similar elevations were noted in the 3 groups which had been fed on beef rations (FD, LE and PP). In addition, lactic acid concentration levels immediately after exercise were lower in the 3 groups receiving the beef ration as compared to 20C and it may be surmised that this was due to the beef activating the biosynthesis of lactic acid-glucose (Cori Cycle).

PERTINENT LITERATURE

Wakamatsu,J., Nagao,T., Numata,M., Nakamura,T., Fujimaki,M. (1996). Anti-fatigue effect of beef, Proceeding of the 42nd ICoMST, Lillehammmer, Norway

Table 1. Effects of freeze-dried beef (FD), lipid-extracted beef (LE) and protein purified from beef (PP) on swimming durations in mice 3 weeks after being fed on experiment rations

Groups	Swimming duration	% of control
	Seconds	
20C	313±65	100
FD	446±90	110
LE	343±72	142
PP	405±81	129

Each value represents the mean ± standard error.

Table 2. Effects of freeze-dried beef (FD), lipid-extracted beef (LE) and protein purified from beef (PP) on hepatic triglyceride and glycogen levels in mice

	Groups	Before swimming	Immediately after swimming	30 min. after swimming
Triglyceride	20C	13.4±3.9	9.8±2.4^{a}	12.0±3.3^{a}
(mg/g liver)	FD	17.7±5.0	28.5±8.1^{bc}	25.1±3.6^{b}
	LE	10.0±2.8	16.2±2.9^{ac}	12.2±2.2^{a}
	PP	9.2±2.0^{x}	16.2±2.9^{ac,y}	6.2±2.5^{a,x}
Glycogen	20C	1205±642	309±147	37±14^{ab}
(μ g/g liver)	FD	639±340	48±14	85±28^{a}
	LE	1513±624^{x}	342±164^{xy}	72±9^{ab,y}
	PP	1139±679	47±17	27±4^{b}

Each value represents the mean ± standard error. ^{abc} values not sharing a common letter are significantly different among the 4 dietary groups at $P<0.05$ by Duncan's multiple-range test. ^{xy} values not sharing a common letter are significantly different among the 3 states before and after swimming at $P<0.05$ by Duncan's multiple-range test.

Table 3. Effects of freeze-dried beef (FD), lipid-extracted beef (LE) and protein purified from beef (PP) on the serum glucose (GLU), lactic acid (LA), 3-hydroxybutyrate (3-HBA), total carnitine (t-CAR) and creatine kinase activity (CK) levels in mice.

	Groups	Before swimming	Immediately after swimming	30 min after swimming
GLU	20C	222±10^{x}	199±18^{x}	129±17^{y}
(mg/dl)	FD	241±6^{x}	196±6^{y}	182±21^{y}
	LE	234±19	213±14	189±35
	PP	227±15	208±15	189±22
LA	20C	12.6±1.3^{xy}	16.4±1.3^{a,x}	9.8±1.5^{y}
(mg/dl)	FD	12.6±0.5^{x}	13.8±1.2^{ab,x}	7.3±0.5^{y}
	LE	11.4±1.0	12.0±0.8^{b}	9.3±0.6
	PP	12.0±3.6	11.4±1.6^{b}	7.6±0.9
3-HBA	20C	15.0±5.4^{x}	36.8±4.1^{y}	54.3±10.2^{z}
(μ mol/l)	FD	15.6±4.0^{x}	39.2±4.6^{y}	58.8±3.8^{z}
	LE	14.8±2.7^{x}	45.2±6.5^{y}	53.0±9.1^{y}
	PP	14.4±2.2^{x}	38.2±1.8^{y}	49.2±3.9^{z}
t-CAT	20C	3088±425	3795±697	2439±725
(μ mol/l)	FD	4202±516^{x}	3483±412^{xy}	2387±269^{y}
	LE	3466±458	3606±281	2809±308
	PP	3714±343	3575±232	2740±408
CK	20C	106±26^{a}	197±62^{a}	107±20
(U/l)	FD	67±7^{ab}	55±9^{b}	80±15
	LE	41±4^{b}	87±23^{b}	86±34
	PP	29±5^{b,x}	72±9^{a,y}	37±8^{x}

Each value represents the mean ± standard error. ^{ab} values not sharing a common letter are significantly different among the 4 dietary groups at $P<0.05$ by Duncan's multiple-range test. ^{xyz} values not sharing a common letter are significantly different among the 3 states before and after swimming at $P<0.05$ by Duncan's multiple-range test.