ANTI-FATIGUE EFFECTS OF BEEF

JUN-ICHI WAKAMATSU[1], TETSUJI NAGAO[2], MASAHIRO NUMATA[1], TOYOO NAKAMURA[1] and MASAO FUJIMAKI[1]

[1]Central Research Institute, Itoham Foods Inc., 1-2, Kubogaoka, Moriya, Kitasouma, Ibaraki., 302-01, JAPAN

[2]Hatano Research Institute, Food and Drug Safety Center, 729-5, Ochiai, Hatano, Kanagawa., 257, JAPAN

Keywords: anti-fatigue effect, beef, organism regulation function, weight-loaded forced swimming

BACKGROUND

Foods have the nutritional function (the first function) of maintaining life, the sensory function (the second function) to stimulate the senses of the taste and smell, and organism regulating functions (the third function) of maintaining homeostasis in the living body and controlling physiological functions.

In ancient Japan, there was no tradition of eating animal meat, it has only been one hundred years since this custom has become widespread. It has been said that meat is nourishing. Many Japanese have the image that meat especially beef builds vitality and vigor. It is also expected that meat will provide special organism regulating functions such as the reduction and/or recovery of fatigue.

Fatigue is classified roughly into physical and mental fatigue, and can involve acute or chronic fatigue and so on. Though the word of "fatigue" is used frequently, a consensus on the concept and definition of the fatigue remains unclear.

OBJECTIVE

The present in vivo study investigated whether beef can reduce fatigue by examining exercise load.

METHODS

Animal and diets: ICR mice (male, 9 weeks old) were fed diets containing 21% protein and 6% lipids for 5 weeks in a biotron (24°C temperature, 55% humidity, 12 hr lightening). Dietary proteins used in the present study were freeze-dried beef powder and milk casein, and dietary lipids were beef tallow (BT) and soybean oil (SO). The diet groups were as follows: Beef+BT, Beef+SO, Casein+SO (Control; Oriental Yeast Co., Tokyo, Japan). Throughout the experimental period, animals were given free access to water and these diets.

Weight-loaded forced swimming: A load weighing 10% of the average body weight of each group was attached to the abdominal region of each mouse. Animals were then placed in water (20 ± 0.5°C). The interval until the head of the mouse sank below the water for more than 7 seconds was regarded as the swimming period.

Hanging after the forced swimming: After mice were placed in water (24 ± 1°C) for 30 minutes, mice were hung from wires (3 mm diameter) 3 and 30 minutes later. Interval until falling from the wire was regarded as the hanging period.

Biochemical parameter examination in the plasma: Glucose (GLU), triglyceride (TG), non-esterified fatty acid (NEFA) and L-lactic acid (LA) in the plasma were examined by a COBAS-FARA autoanalyzer (Roche Diagnostic Systems, Montclair, NJ).

Statistical analysis: Significance of differences between any two groups was determined by Student's *t* test. A value of $P<0.05$ was considered significant.

RESULT AND DISCUSSION:

All of the experimental groups showed a similar body weight at the end of the study. The dietary intake changed similarly in each group and there were no significant differences among groups. Because there were no abnormalities detected on dissection, and there were no negative effects from ingesting beef or beef tallow, it was considered that long-termed ingestion of beef did not have a bad influence upon mature mice.

Table 1 shows the swimming period of mice fed Beef+BT was significantly prolonged ($p>0.05$). That of mice fed Casein+BT tended to be prolonged, but was not significantly different from that of the control.

The hanging period after forced swimming in mice fed Beef+BT and Casein+BT was significantly prolonged ($p>0.05$) after 3 min (Table 2). After 30 min, only mice fed Beef+BT showed a significantly prolonged hanging period compared to that of controls ($p>0.05$). These results suggest that beef, especially lean meat may have an anti-fatigue effect.

Table 3 shows changes in GLU, TG, NEFA and LA in plasma after forced swimming. The GLU and LA levels in plasma of mice fed the casein diet were remarkably reduced compared to these levels prior to exercise. In the Beef+BT-fed mice, the pre-exercise GLU level equalled and the pre-exercise LA level was slightly increased compared to the post-exercise levels. The changes in these four parameters in the Beef+BT-fed group were less than those in the control group. Therefore, these results suggested that beef was prominent to maintaining organism homeostasis, but further work is need to determine whether beef provides anti-fatigue effects and to determine the effective nutrients in beef.

CONCLUSIONS

The long-term intake of beef and/or beef tallow did not negatively influence mice with regard to appearance, transition of body weight, food intake and findings on dissection.

Significant or positive results in the Beef+BT group were recognized on the anti-fatigue tests, such as weight-loaded forced swimming and hanging after forced swimming. Beef especially lean meat demonstrated anti-fatigue effects.

PERTINENT LITERATURE

Fujimaki, M. (Ed.). 1988. Systematic analysis and development of food functionalities, Japan Scientific Society Press center, Tokyo, Japan.

Table 1. Weight-loaded forced swimming period

Groups	Times (sec)
Beef + BT	326 ± 14.8*
Casein + BT	271 ± 31.3
Casein + SO	245 ± 28.6

Values are means ± S.D., n= 20 mice/groups

*: Significant different from Control (Casein + SO), $p<0.05$

Table 2. Hanging period after forced swimming

Groups	3 min later	30 min later
	sec	
Beef + BT	14.2*	13.5*
Casein + BT	15.1*	10.1
Casein + SO	9.2	10.6

Values are means, n= 20 mice/groups

*: Significant different from Control (Casein + SO), $p<0.05$

Table 3. Some biochemical parameters in plasma before and after the forced swiming

	Groups	before	after
GLU (mg/dl)	Beef + BT	227.9 ± 8.0	221.4 ± 19.1*
	Casein + BT	238.3 ± 6.2	196.6 ± 10.1#
	Casein + SO	245.6 ± 9.3	184.5 ± 11.1#
TG (mg/dl)	Beef + BT	90.4 ± 8.8*	94.7 ± 10.4
	Casein + BT	73.3 ± 6.5*	73.3 ± 5.6
	Casein + SO	113.3 ± 17.0	93.2 ± 10.8
NEFA (mEq/l)	Beef + BT	0.83 ± 0.08*	0.87 ± 0.11
	Casein + BT	0.69 ± 0.04	0.78 ± 0.09
	Casein + SO	0.69 ± 0.06	0.94 ± 0.11
LA (mg/dl)	Beef + BT	24.7 ± 2.3	27.5 ± 5.1*
	Casein + BT	25.5 ± 3.4	19.9 ± 3.5#
	Casein + SO	26.7 ± 3.9	18.4 ± 2.2#

Values are means ± S.D., n= 10 mice/groups

*: Significant different from Control (Casein + SO), $p<0.05$

#: Significant different from pre-exercise levels, $p<0.05$