8-P45

LOSS OF L-CARNITINE FROM BEEF DURING COOKING

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Background:

L-Carnitine (β-hydroxy-γ-trimethylaminobutyric acid; Vitamin B_T) is essential for fat metabolism as a vitamin-like material. Major roles of carnitine are 1) the intake of long-chain fatty acids into the mitochondria, 2) the removal of excess fatty acids (acyl CoA) outside the mitochondria (excessive amounts are harmful) and so on. Recently, it has been established that L-carnitine has a relation with various diseases such as cardiac diseases, hyperlipemia, kidney diseases, liver diseases and diabetes (Borum, 1983).

L-carnitine is not a vitamin in the strictest sense, because it is synthesized in the human body, however, large amounts are absorbed from food as well. Compared to grains and vegetables the amount found in animal products is by far greater. Among the meats normally eaten in Japan (beef, pork and chicken), the greatest amounts are found in beef. (Tada et al., 1985). Thus, it may be said that in Japan, the main source of L-carnitine is beef.

As L-carnitine is a small molecule with high solubility, losses during storage and cooking due to drippage can be posited. Moreover, losses of L-carnitine in meats after slaughter have been confirmed (Nelson et al., 1985).

Objectives:

The use of synthesized L-carnitine as a food is permitted in Europe and America, however, it as it is classified as a drug for medical use in Japan, it's use as a food is not permitted. As the majority of L-carnitine comes from meat products, the objective of this study is to confirm the amounts of loss which occur in various cooking procedures used with beef products in order to determine the optimal supply method.

Methods:

Domestic beef available on the market bearing the label "Japanese black" was used and cooked in accordance with the procedure described by Tsukamoto et al. (1989).

1) grilled・thin slice: The beef was cut to the dimensions of 50×100×2 mm, placed on a well-heated grill and grilled for 7-8 seconds before turning it over to grill the other side for an equal amount of time.
2) grilled・thick slice: The beef was cut to a size of 50×100×20 mm, placed on a well-heated grill over a medium flame and grilled for 2 minutes before turning it over to grill the other side for an equal amount of time.
3) Fried in a frying pan・thin slice: The beef was prepared in the same manner as was used for grilling. 5 grams of beef fat were heated in a flying pan (25 cm diameter) and the beef was fried 7-8 seconds using a medium to strong flame before turning it over to fry the other side for an equal amount of time.
4) Fried in a frying pan・thick slice: The beef was prepared in the same manner as was used for grilling. 10 grams of beef fat were heated in a flying pan (25 cm diameter) and the beef was fried for 30 seconds using a medium to strong flame before reducing the heat to a low to medium flame for 1 minute and 30 seconds before turning it over to fry the other side for an equal amount of time.
5) Boiled・thin slice: Beef was sliced thin (approx. 1mm). Water was put into a pot and brought slowly to a boil. The beef slice was inserted into boiling water using chopsticks 2-3 times, moving it back and forth in the water.
6) Boiled・block of beef: Beef was cut to 100×100×50 mm. 1,000ml of water were added to a heavy saucepan (18 cm diameter), the beef inserted, and heated over a strong flame. After the water came to a boil, the fat floating on the surface was skimmed off and cooking continued over a low flame for 10-15 minutes. The boiled beef was pink at the center.
7) Stewed・cubes: Beef was cut to 40×40×40 mm and placed in a heavy saucepan (18cm diameter) containing twice the volume of water as the weight of the beef and brought to a boil over high heat at which time the fat floating on the surface was skimmed off. After coming to a boil, cooking was continued for 90 minutes over a low flame.
8) Deep-fried・cubes ("Karaage"): Beef was cut to 20×20×20 mm and coated with potato starch. Oil was poured into a pot and heated after the beef was deep-fried for 5-6 minutes at 160-170℃.
9) Deep-fried・thin sliced ("Tempura"): Beef was cut to 50×100×2 mm and dipped them into a mixture of flour and water. Oil was poured into a pot and heated, after the beef was deep-fried for 2-3 minutes at 170-180℃.

Carnitine measurement: Free carnitine and acid soluble carnitine were determined using DTNB assays (Marquis and Fritz, 1964; Pearson et al., 1969) with modification. Short-chain acyl carnitine was measured in term of total acid soluble carnitine minus free carnitine (Pearson et al., 1969). L-carnitine purchased from Tokyo Chemical Industry Co. (Tokyo, JAPAN) was used as standard. Beef was weighed before and after cooking, and the carnitine concentrations compared per 100 g raw beef.

Results and Discussion:

L-carnitine concentrations in beef were reduced regardless of the heating method used for cooking(cf. Fig.) and these results were similar those reported by Nelson et al., (1985). In grilling and frying, free L-carnitine levels decreased only about 10% regardless of the method or the thickness used, however, a difference between methods was seen in the decrease of short-chain acyl carnitine levels with a decrease of approximately 40% in the thin sliced beef as compared to a decrease of approximately 30% in thickly sliced beef.

Boiling thinly sliced beef, as is done in the Japanese meat dish known as "shabu-shabu", results in a slightly larger loss of carnitine as compared to grilling or frying and it was surmised that the boiling water caused the elution of carnitine. (Note: Shabu-shabu is thinly sliced meat dipped in boiling water.) It may be posited that boiling thin slices of beef for even longer periods will result in the further loss of L-carnitine. On the other hand, L-carnitine loss in boiling the beef block was lower than that of boiling the sliced beef. Overall (free and short-chain acyl) carnitine were reduced only 15%. The greatest loss of carnitine was seen in stewing, with both free carnitine and short-chain acyl carnitine being reduced by over 50%. Stewing the beef cubes appeared to have resulted in the carnitine dissolving in the boiling water during the 1.5 hours of cooking.

Carnitine losses were least in the deep-frying method for cubed beef which did not use water. The losses of the highly soluble short-chain acyl carnitine were the least and decreases in free L-carnitine were negligible. However, carnitine in the water-flour battered sliced beef was comparatively large. In this case, the carnitine contents after cooking were determined in beef from which the batter had been removed. It is possible that some of carnitine moved to the batter layer.

Because of the relatively high dissolution point of L-carnitine (196-197℃) , it would appear that carnitine would not be dissolved by general cooking methods. It may be surmised that carnitine is dissolved in the water used for cooking which accounts for its decrease in the beef. Thus, in order to prevent the loss of carnitine in cooking, the use of thin beef should be avoided, and methods using no water and short cooking times opted for. In boiling and stewing cooking methods, it would be advisable to drink the broth the beef is cooked in to absorb the L-carnitine contained in it.

Conclusions:

Losses of L-carnitine were greater in the thinly sliced beef than the thick slices in all methods of cooking used. There were no significant losses in carnitine in comparing the grilling and frying methods. In stewing methods involving cooking over a long time period of time, carnitine levels decreased greatly. In all of the cooking methods, acyl carnitine losses were greater than free carnitine.

Pertinent literature:

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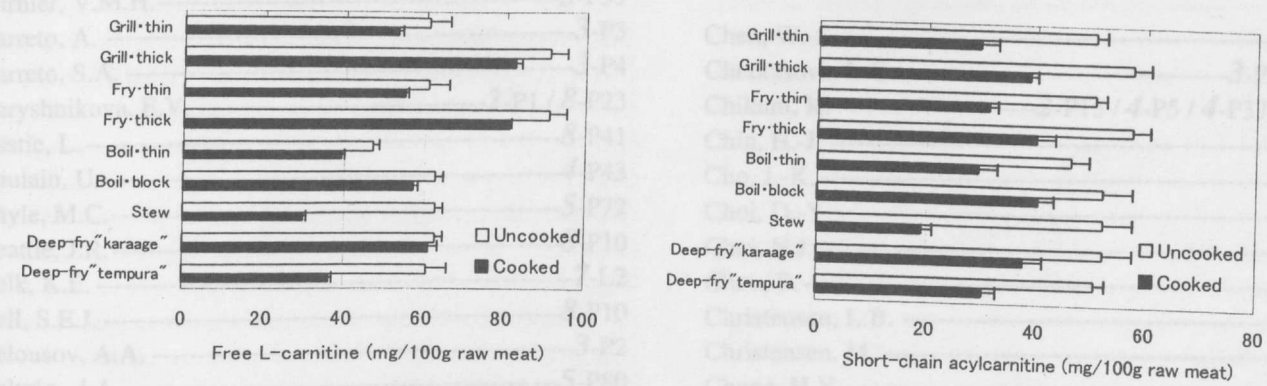

Fig. L-Carnitine concentration in beef before and after cooking.
Each value represents the mean ± standard deviation.