Note

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Pilot study for elucidating paleo diet by stable carbon and nitrogen isotope ratio analysis of charred residue of foods

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Kimihide Ohmichi [a)], Takahiro Kobayashi [a)], Sachie Sainen [a)], Takayuki Mifune [a)], Rumiko Nakashita [b)], Yaeko Suzuki [c)]

a) Division of Medical Nutrition, Faculty of Healthcare, Tokyo Healthcare University
b) Forestry and Forest Products Research Institute
c) Food Research Institute, National Agriculture and Food Research Organization (NARO)

Abstract

The aim of this study is to elucidate and reconstruct paleo diets using the carbon and nitrogen isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) of charred residue on earthenware pots. It is necessary to consider whether there are any significant differences in the $\delta^{13}C$ and $\delta^{15}N$ values of modern foods between before and after cooking. In this study, we investigated the changes occurring during the boiling of foods (sea bream, coho salmon, hard-shell clam, wakame, rice, and millet) in the earthenware pot. In addition, we examined the fluctuations in $\delta^{13}C$ and $\delta^{15}N$ values in the charred residue. We defined the cases where $\delta^{13}C$ and $\delta^{15}N$ values varied by more than 1.0 ‰ and 3.0 ‰, respectively, as "varied". The $\delta^{13}C$ "variation" was small within 1.0 ‰ except sea bream which indicated decreases of 1.4-1.8 ‰. The change in $\delta^{15}N$ values was less than 3.0 ‰ in all charred residue samples. The $\delta^{13}C$ and $\delta^{15}N$ values were likely to be almost maintained during boiling. This result suggested that $\delta^{13}C$ and $\delta^{15}N$ values of charred residue depended on the food group, such as fish, shellfish, seaweed, and C_3 and C_4 plants. Thus, we may discriminate the food groups of charred residues using their $\delta^{13}C$ and $\delta^{15}N$ values.

Keywords : paleo diet, charred residue, stable isotope ratio analysis, $\delta^{13}C$ and $\delta^{15}N$

I Introduction

In the field of archeology, black parts on the inner surface and the rim section of earthenware are presumed to be the charred residue of scorched product derived from food cooking. In this regard, based on the information of the stable isotope ratio of pottery black parts, studies have been performed to estimate the ingredients that were used in ancient times[1-4].

To investigate an ancient food based on the analysis of earthenware samples for preliminary information; however, it is necessary to consider whether any chemical variation occurs during cooking. Yoshida *et al.* mentioned that the change in the $\delta^{13}C$ values was small within 2 ‰ except one sample (Jack in the pulpit)[3]. However, they also reported that the $\delta^{15}N$ values increase by ~4 ‰ in red bean and sesame and to lesser extents in other samples, except for one sample (raccoon dog)[3]. Poole *et al.* reported a change between -0.5 ‰ and +2 ‰ in the $\delta^{13}C$ values in a heating experiment using peas; the direction of the change was also not consistent[5]. Yang *et al.* charred millets and observed changes in the $\delta^{13}C$ values of less than 1 ‰ in both directions[6]. Kanstrup *et al.* charred wheat grains and inferred little change in the $\delta^{15}N$ values[7]. Zhou *et al.* reported that the boiling, frying, and roasting processes had no significant effect on the stable carbon and nitrogen isotopic composition of beef[8]. Fraser *et al.* revealed increases of ~1 ‰ in the $\delta^{15}N$ values of cereal grain and pulse seed, and there is no consistent impact on their $\delta^{13}C$ values[9]. Thus, the regularity of fluctuations in the $\delta^{13}C$ and $\delta^{15}N$ values before and after cooking is controversial, as mentioned above.

Unfortunately, these previous archaeological studies have focused mainly on pot residues and little experimental research has been done on actual food remains themselves[9]. A pilot study was required to accumulate basic knowledge

Corresponding author: Kimihide Ohmichi, Division of Medical Nutrition, Faculty of Healthcare, Tokyo Healthcare University, 3-11-3 Setagaya-ku, Tokyo 154-8568, Japan