Investigations on the use of trace elements for authentication of the origin of poultry and beef

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Introduction

Consumer demands for authenticity of the origin of meat are rapidly increasing. For 82% of the customers, origin of food is important for their purchase decision (Anonymous, 2004a). Therefore, sophisticated analytical tools are required to prove the origin of food, a result being valuable also to organizations controlling stated origins of the products and to producers. For dried beef from the Swiss canton of Valais, for instance, producers claim the exclusive use of Swiss raw beef (Anonymous, 2002), different from producers of such products in canton Grisons ('Bündnerfleisch'). The country of origin is of great interest for poultry, too, regarding the current avian influenza situation, for example.

Trace elements might help to discriminate between different origins of meat. Rare elements and those not commonly supplemented to animal diets seem to be promising in that respect since they are more likely to be region-specific (Franke et al., 2005). For example the Se content of American soils is known to be much higher than that in Europe, and the isotopic ratio of Sr is known to be influenced by the type of geological underground (Capo et al., 1998). Also Rb is of interest as it was found to be enriched in granite and gneiss weathering soil (Anke and Angelow, 1995). Another good option to prove origin is seen in Lanthanides because they are used for decades in certain countries (e.g. China) in pig fattening as growth promoters (Eisele, 2003).

Material and Methods

In order to test the potential of using trace elements to authenticate the geographic origin of meat, two different commodities were selected. The first one was poultry, the most imported meat type in Switzerland (Anonymous, 2004b), where production factors (feed, genotype) with the exception of drinking water and litter are widely globalized and therefore uncoupled from regional origin. The second commodity was

a high-priced dried beef product where the production of the raw beef depends more on geographic origin but where the trace element profile might also be influenced by transformation from raw meat into the final product (curing salts, herbs etc.).

Poultry breasts from Thailand (n=3), France (n=2), Germany (n=3), Hungary (n=6), Brazil (n=4) and Switzerland (n=7) were obtained. The authenticity of the samples was confirmed by official customs documents where the abattoir was stated. The dried beef meat samples originated from Austria (n=2), Australia (n=1), Canada (n=2) and Switzerland (Valais (n=3) and Grisons). The samples from Grisons were sub-divided into raw beef origins from Switzerland (n=4) and Brazil (n=4). Furthermore, two Swiss produced samples of Bresaola, another type of dried beef, were obtained, one prepared from Swiss and one from Brazilian raw meat. All dried beef samples were either collected at the point of production in Switzerland or imported directly from the producers abroad.

Poultry samples were deep frozen and beef samples were stored at +5°C in vacuumized plastic bags. The poultry samples were homogenized using a Büchi Mixer B 400 (Büchi Labortechnik AG, Flawill, CH) equipped with a ceramic knife. Afterwards, 1 g of poultry and 0.5 g of dried beef respectively were subjected to micro-wave assisted pressure digestion with nitric acid. In order to test the quality of the measurements, reference materials (lyophilized bovine muscle BCR 184, Reference Material 8414 NIST) were digested and analyzed together with the samples, which were analyzed for a total of 75 elements/isotopes using a sector field ICP-MS (Element 2, Finnigan MAT, Bremen, D). Multiple linear regression with backward eliminitation was performed as discriminant analysis to determine the extent to which the variation among samples was explained by distinct combinations of elements/isotopes.

Results

The samples were grouped into Swiss (x) and non-Swiss (o) categories. In poultry breast, 60% of the total variance ($p<0.001$) were explained due to B, Ca, Co, Tl. Ca and Tl alone explained 42% of the total variance ($p<0.01$) (Fig. 1). In beef, 86% of the total variance ($p<0.05$) of samples made from Swiss raw meat and foreign raw meat were explained by Ca, Cu, Li, Pd, Rb, Sc, Sr, Tl, U and V, while Li, Rb and Tl alone explained 80% of the total variance ($p<0.001$). With these three elements it was possible to differentiate the samples according to the origin of their raw meat. Rare

earth elements could hardly be detected in any of the samples.

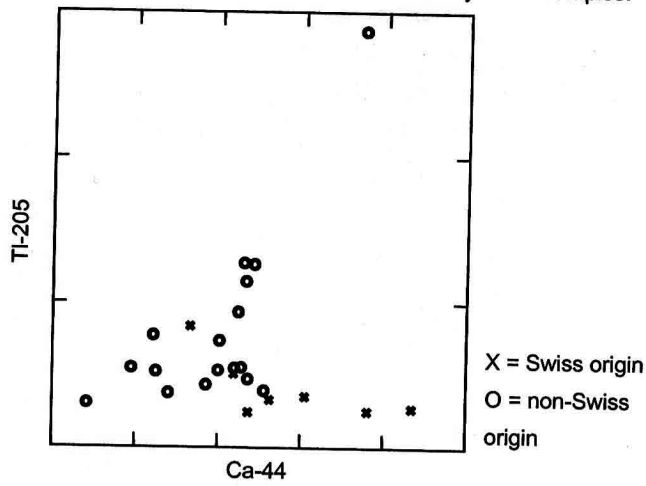

Figure 1. Elements allowing the partial differentiation of poultry meat from Swiss and non-Swiss origin

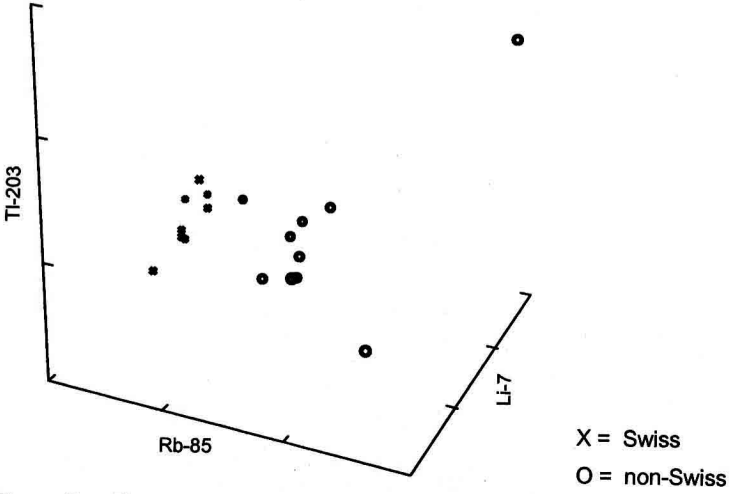

Figure 2. Elements allowing differentiation of dried beef meat produced from Swiss and non-Swiss raw meat

Discussion

The present results show that trace elements can be used to obtain indications of the

geographic origin of poultry breast and dried beef meat. In both cases, few elements/isotopes explained most of the variation. Poultry could not be completely differentiated into two groups (Swiss and non-Swiss origin) when using the elements Tl and Ca, although there were a lot of samples which could be classified correctly. In the case of dried beef, a clear differentiation of Swiss and foreign raw meat was possible. Results obtained with processed meat have to be interpreted carefully because processing might modify the characteristic trace element profile of meat and thus cause a bias with geographic origin. Our results demonstrate a large potential of trace elements for differentiating meat by geographic origin. Combinations with other methods would further improve the accuracy of meat authentication.

Summary

Trace elements, discussed as to be promising to prove geographic origin of meat, were determined in poultry and dried beef. Poultry breasts were obtained from Switzerland and five other countries. Dried beef samples originated from Switzerland (two regions and, in one region, raw beef from Switzerland or Brazil) and three other countries. A total of 75 elements/isotopes were analyzed by using a sector field ICP-MS combined with subjection through micro-wave assisted pressure digestion with nitric acid. A relatively good differentiation of meat from Swiss and from non-Swiss origin was possible with Ca and Tl for poultry and Li, Rb and Tl for dried beef.

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