

Opportunities and limitations of the analytical determination of the geographic origin of poultry meat and dried beef

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Abstract

Proving meat authenticity is of increasing interest to consumers, authorities and processors worldwide. The present study was initiated to verify the geographic origin of fresh and processed meat by identifying suitable analytical tools. 78 broiler breast samples from five countries (Brazil: n=14; France: n=13; Germany: n=15; Hungary: n=16; Switzerland: n=20) and 74 dried beef samples from different raw meat origins and processing places [Australia: n=8; Austria (Brazilian raw meat): n=6; Grisons: Brazilian raw meat: n=16 and Swiss raw meat: n=16; Valais (Swiss raw meat): n=15; Canada: n=8; USA: n=5; raw meat origin = processing place, when not specified] were analysed for $\delta^{18}\text{O}$ and composition of various elements. ANOVA, LDA and validation were used as statistical tools. The results showed that a differentiation of certain origins was feasible. However, it was not possible to unanimously determine the origin of samples of unknown origin as not every origin could be clearly separated from each other. Additionally analysis by NIR and NMR of dried beef did not allow an unambiguous discrimination of raw meat origin and processing place. The techniques investigated were not suitable to prove misdeclarations of meat exclusively, but processors and authorities may obtain indications triggering further investigations of potential frauds.

Introduction

The verification of the origin of meat is getting more and more important in the public view due to various food scandals in the last years. The present way of proving the origin is by accompanying custom documents (paper traceability). Therefore new tools for origin determination are required, especially for meat. This is why the possibility of directly proving the origin based on certain meat characteristics would open new ways in traceability. This would lead to an additional protection against false declarations, which would be useful for local processors as well as for consumers.

Material and methods

In the context of an extensive research project, 78 broiler breast samples from five countries were examined for their origin (Brazil: n=14; France: n=13; Germany: n=15; Hungary: n=16; Switzerland: n=20). The samples were stored vacuum-sealed at -25°C . Furthermore, 74 dried beef samples from different raw meat origins and different processing places [Australia: n=8; Austria (Brazilian raw meat): n=6; Switzerland, canton of Grisons (Brazilian raw meat: and Swiss raw meat): n=2×16; canton of Valais (Swiss raw meat): n=15; Canada: n=8; USA: n=5; raw meat origin = processing place, when not specified]. These samples were stored vacuum-sealed at 2.5°C .

All samples were analysed according to their oxygen isotope ratio (Franke et al., 2008) and their element composition (Franke et al., 2007a; Franke et al., 2007b). For both meat types, the investigations were accomplished in two steps (P1 and P2), where P1 contained a smaller and P2 a larger sample set.

Dried beef samples were additionally analysed using NMR (Shintu et al., 2007) and NIR.

For the statistic evaluation, ANOVA was used for techniques with only one parameter ($\delta^{18}\text{O}$). Results consisting of several parameters (element analyses) were statistically analysed using LDA, where the most promising parameters were evaluated and classification matrices of step 1 on basis of the data set of step 2 were build.

Results and discussion

Both, element and $\delta^{18}\text{O}$ data allowed the discrimination between certain origins, but not all origins could clearly be separated from each other. It was also not possible to determine the origin of an unknown sample.

For poultry meat, oxygen isotope ratio allowed to differentiate between three groups: i) Brazil and France; ii) Germany; iii) Hungary and Switzerland. Using element analysis, Brazil and France could be

separated from each other and from Germany, Hungary and Switzerland. But the latter three origins could not be differentiated from the others at all (Table 1).

Table 1. Differentiation of the origins of poultry breasts according to element analysis and $\delta^{18}\text{O}$ techniques (data from Franke et al., 2007ab, 2008)

	Elements	$\delta^{18}\text{O}$
Separation based on	Validation P1 on basis of P2	ANOVA
Brazil	France, Germany, Hungary, Switzerland	Germany, Hungary, Switzerland
France	Brazil, Germany, Hungary, Switzerland	Germany, Hungary, Switzerland
Germany	---	Brazil, France, Hungary, Switzerland
Hungary	---	Brazil, France, Germany
Switzerland	---	Brazil, France, Germany

With dried beef, a separation of Canadian meat as well as of Austrian dried beef from all the other origins was possible by means of element analyses. Also a separation from dried beef from Grisons was possible, which was partly processed of Brazilian raw meat (Table 2). Within Swiss samples a distinction between the production places Valais and Grisons was not possible by $\delta^{18}\text{O}$, just as a distinction between Brazilian and Swiss raw meat within Swiss dried beef from Grisons. However, dried beef from Valais could be distinguished from that from Grisons made of Brazilian raw meat.

Further investigations using NMR and NIR did not result in any clear differentiation of various dried beef origins.

Table 2. Differentiation of the raw meat origin and place of processing of dried beef according to elemental analysis, IRMS, NIR and NMR techniques (data from Shintu et al., 2007; Franke et al., 2007ab, 2008)

Raw meat origin	Place of processing	Elements	$\delta^{18}\text{O}$	NIR	NMR
Separation based on		Validation	ANOVA	Validation	
Australia (AU-AU)	Australia	BR-AT, BR-GR, CH-VS, CN-CN, US-US	all other	no differentiation possible	Results in step 2 did not confirm results of step 1 → no validation done
Brazil (BR-AT)	Austria (AT)	all others	AU-AU, CN-CN	no differentiation possible	
Brazil (BR-GR)	Grisons (GR)	other except CHGR	AU-AU, US-US, CN-CN	no differentiation possible	
Switzerland (CH-GR)	Grisons (GR)	non-Swiss samples	AU-AU, CN-CN	no differentiation possible	
Switzerland (CH-VS)	Valais (VS)	samples of non-Swiss raw meat	AU-AU, CN-CN	no differentiation possible	
Canada (CN-CN)	Canada	all others	all except US-US	no differentiation possible	
USA (USUS)	USA	---	BR-GR, AU-AU	no differentiation possible	

The first two letters indicate the raw meat origin, the last two letters the place of processing; GR and VS are part of CH

Conclusions

The results of the present study indicate that a distinction of certain origins is possible. However, not every origin can be clearly separated from all the others and it was not possible to determine the origin of an unknown sample. Nevertheless, in some cases our results allowed to control whether or not a given sample is compatible with the origin being stated on the label. This might be an additional hint for the food control authorities to launch further investigations on site. Unfortunately, a clear differentiation of poultry meat as well as of dried beef is not possible if data are only based on the procedures presented.

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