Determination of volatile organic compounds responsible for flavour in cooked river buffalo meat

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ABSTRACT: Flavour is an important consumer attractive that directly influences the success of food products on the market. The determination of odorous molecules and their identification allows to useful knowledge for producers to valorise their own products. Buffalo meat has a different chemical composition from pork and beef and requires some cautions in cooking and processing. This work aims at the identification of volatile molecules responsible for flavours in river buffalo meat. The determination was carried out by solid phase micro-extraction (SPME) technique and analysed by gas chromatography coupled to mass spectrometry (GC-MS). The most relevant results were the higher odorous impact of buffalo meat and the higher content of sulphide compounds responsible for wild aroma respect to pork and beef. These results were obtained comparing the total area of peaks detected in every chromatogram. We have also found significant differences concerning the contents of pentadecane, 1-hexanol-2 ethyl, butanoic acid, furano-2-pentyl. The origin of volatile organic compounds and their influence on the river buffalo aromas were discussed.

Key words: Buffalo, SPME, VOC, Meat.

INTRODUCTION - The Mediterranean Italian buffalo, a genetically improved breed, is reared essentially for milk to manufacture mozzarella cheese. In Campania region new initiatives have recently been undertaken in order to promote buffalo meat market. The results deriving from this interest have been reported on proceedings of 1st buffalo Symposium of Europe and the Americas (2005). Although buffalo meat has interesting nutritional properties the market demand still remains very small because of alimentary habits of consumer and insufficient information.

Low total lipid and cholesterol content (Kesava Rao et al., 1996; Di Luccia et al., 2003; Devatkal et al., 2004; Infascelli et al., 2005; Sacchi et al., 2005), good water holding capacity (Infascelli et al., 2004) and organoleptic characteristics similar to beef (Pellicano et al., 2005) makes buffalo meat an important alternative meat source. However, buffalo meat has a rapid darkening, that can be reduced supplementing the diet with vitamin E (Barone et al., 2005; Zicarelli et al., 2005). In this paper volatile organic compounds (VOC), contained in
static head space of cooked buffalo meat, were investigated by solid phase micro-extraction (SPME) and gas chromatography coupled with mass spectrometry (GC/MS). Furthermore a comparison between VOCs of buffalo, beef and pig meat was performed.

MATERIAL AND METHODS - Samples of pork and beef were collected from three different butcher, buffalo meat was bought from three Campania’s breeders. All samples, derived from *Longissimus dorsi*, were trimmed of visible fat and minced. Ten grams of minced meat were weighted in a 50 ml cupped vials and oven cooked at 140 °C for 15’. Then vial was made cool and equilibrated for 20’ at 45 °C. The extraction of volatiles compounds was performed in 30’ by a SPME fiber 75μm Carboxen – PDMS from Supelco, previously activated as recommended by manufacturer, exposed in the headspace of vial. Volatiles compounds were desorbed for 4’ in a splitless injector, set at 250 °C. A GC Fisons 8000 equipped with a SPB-624 column (30m, 0.25mm i.d., 0.25μm film thickness) coupled with MD800 was used. Chromatographic conditions were: oven temperature 40 °C, isocratic for 1 minute then increase at 3 °C/min until 230 °C, gas transporters Helium at a constant pressure of 30 kPa. Mass spectrometer setting was: 250 °C source, 200 °C Interface, 70 eV energy, 150 mA emission, 500 V detector voltage, full scan acquisition mode from 40-300 uma. All data were expressed as absolute area, “t” test was used to evaluate differences.

RESULTS AND CONCLUSIONS - The GC/MS analyses led us to the identification of 101 compounds by external standard injection and mass spectrum matching with that present in Wiley and Nist database. Our results were consistent with VOCs identified by other authors in cooked meat (Brunton *et al*. 2000; Wettasinghe *et al*. 2001; Elmore *et al*. 2000). To provide an easier understanding of all data acquired, two indexes were found: i) the sum of all peaks area to represent the complexity and intensity of the odorous impact and ii) the sum of peaks area of all sulphide compounds to evaluate unpleasant smell. Figure 1 shows the most representative chromatograms of the three kinds of meat.

The comparison of these chromatograms shows two main results: the sum of total peak area and the content of sulphide compounds were higher in buffalo meat than in the other two species (Figure 2). The sulphide compounds have a very low olfactory threshold, an unpleasant smell described as onion, and originate from methionine by strecker degradation. Moreover, pentadecane (retention time 50.45±0.01), dimethyldisulphide (11.69), hexanoic acid (29.77) were present only in river buffalo meat, while hexanol-2-ethyl (29.59) was absent in river buffalo meat and present in the same quantity in pork and beef. Another important difference concerned the hexanal (15.32) and 3-Hydroxy-2-butanone (acetoin, 12.00) content. The former derives from lipid oxidation (linoleic acid) and is associated to grass or fatty flavor, the latter derives from carbohydrate metabolism and is described as almond flavour. Hexanal is predominant in pork while acetoin in buffalo meat. Therefore river buffalo meat is characterized by a more intense aroma and unattractive notes that could be perceived because of sulphide compounds content.

Although our data rationalization allowed us to an easy and prompt evaluation of olfactory impact it is necessary to consider that the perceived smell is the result of complex composition of volatile organic compounds due to their nature and different proportion as well as their interaction. Thus, further studies are necessary to deepen the aspects on meat flavour development.
Figure 1. Chromatograms of headspace in pork, buffalo and beef cooked meat.

Figure 2. Total peaks area and sulphide content of the three type of meat.
REFERENCES - Barone, C.M.A., Consolante D., Zullo A., Zicarelli L. 2005. Vitamin E effects on colour stability of buffalo meat. 1st Buffalo Symp. Of Europe and the Americas. 12-15 October, Capaccio-Paestum, 158. Brunton, N.P., Cronin, D.A., Monahan F.J., Durcan, R. 2000. A comparison of solid-phase microextraction (SPME) fibres for measurement of hexanal and pentanal in cooked turkey. Food Chemistry. 68: 339-345. Di Luccia, A., Satriani, A., Barone, C.M.A., Colatruglio, P., Gigli, S., Occidente, M., Trivellone, E., Zullo, A., Matassino, D., 2003. Effect of dietary energy content on the intramuscular fat depots and triglyceride composition of river buffalo meat. Meat Science. 65: 1379–1389. Devatkal, S., Mendiratta, S.K., Kondaiah, N., Sharma, M.C., Anjaneyulu, A.S.R. 2004. Physicochemical, functional and microbiological quality of buffalo liver. Meat Science. 68: 79–86. Elmore, J.S., Mottram, D.S., Hierro, E. 2000. Two-fibre solid-phase microextraction combined with gas chromatography–mass spectrometry for the analysis of volatile aroma compounds in cooked pork. Journal of Chromatography A. 905: 233–240. Infascelli, F., Gigli, S., Campanile, G., 2004. Buffalo Meat Production: Performance infra vitam and Quality of Meat. Veterinary Research Communications. 28: 143–148. Infascelli, F., Cutrignelli, M.I., Bovera F., Tudisco R., Calabrò, S., Zicarelli, L., D’Urso, S., Piccolo, V. 2005. Cholesterol content and fatty acids composition of meat from buffalo and Marchigiana young bulls.1st Buffalo Symp. Of Europe and the Americas. 12-15 October, Capaccio-Paestum, 146. Kesava RAO, V., Kowale, B.N., Babu, N.P., Bisht, G.S. 1996. Effect of cooking and storage on lipid oxidation and development of cholesterol oxidation products in water buffalo meat. Meat Science. 43(2): 179-185. Pelicano, M.P., Cammarota, G., Cipriano, L., Tarantino, K., Picciocchi, N., Graziani, M.P. 2005. Evaluation of the sensory qualities of buffalo meat and identification of choice factors.1st Buffalo Symp. Of Europe and the Americas. 12-15 October, Capaccio-Paestum, 145. Sacchi, R., Battimo, I., Bavarese, M., Romano, R., Chianese, L. 2005. Lipids of buffalo (Bubalus Bubalus L.) meat. 1st Buffalo Symp. Of Europe and the Americas. 12-15 October, Capaccio-Paestum, 150. Wettasinghe, M., Vasanthan, T., Temelli, F., Swallow, K. 2001. Volatile flavour composition of cooked by-product blends of chicken, beef and pork: a quantitative GC-MS investigation. Food Research International. 34: 149-158. Zicarelli, L., Amante, L., Campanile, G., Di Palo, R., Zicarelli, F. 2005. Mediterranean Italian buffalo young bull production. Note II: Supplementation with vitamin E in the last growing phase. 1st Buffalo Symp. Of Europe and the Americas. 12-15 October, Capaccio-Paestum, 156.