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VOLATILE FLAVOUR COMPOUNDS OF HERZEGOVINIAN DRY SMOKED GOAT MEAT

ABSTRACT

The volatile flavour compounds of Herzegovinian dry smoked goat meat were investigated by using headspace-solid phase microextraction (SPME) and gas chromatography–mass spectrometry (GC–MS). A total of 97 volatile compounds were identified and quantified which belonged to several chemical groups: phenols (75.12%), aromatic hydrocarbons (17.47%), aldehydes (3.89%), acids (3.55%), alcohols (2.07%), ketones (1.60%), furans (0.36%), hydrocarbons (0.29%), terpenes (0.19%), esters and lactones (0.06%). The most common groups of volatile compounds in the samples of Herzegovinian dry smoked goat meat were phenols, aromatic hydrocarbons and aldehydes. Of all the identified compounds, the most common were p-cresol, creosol and 2,6-dimethoxyphenol, which were formed in the smoking process. PCA analysis showed that a positive correlation was found between the content of phenol and hydrocarbons, alcohols, ketones, esters and lactones, and terpenes, aromatic hydrocarbons and acids. Phenols as the most represented group of volatile compounds was characteristic for the leg sample (83.03%).

Keywords: Herzegovina, dry smoked goat meat, traditional product, aroma, volatile compounds

INTRODUCTION

The production of goat meat in the world, although four times smaller than the production of sheep meat, is of great importance for many countries, especially for the countries of Asia, Africa and South America. In the countries of the European Union, the production of goat meat is of significantly less importance and scope, especially in countries where dairy goat breeds are raised and where meat is a secondary product (Memiši *et al*., 2009). The importance of goat breeding has continuously declined for a long time, and in the 1990s, this branch of animal husbandry regained its importance (Žujović *et al*., 2005). That is when the imports of Boer goats, which are highly selected for meat production,

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begin. The decline in the importance of goat breeding is a consequence of the introduction of partial or complete bans on breeding goats, especially the Law on Prohibition of Goat Breeding, which was passed in 1954. The Law had a negative impact on the reduction of the number of goats, on the absence of any systematic breeding and selection work in the production, as well as on the complete extinction of already formed types or breeds (Antunović *et al*., 2012). Favorable climatic conditions, the possibility of producing cheap and good quality food, large quantities of floorcloth, smaller financial investments and the possession of certified organic land areas are very good prerequisites for the spread of organic livestock farming, including goat farming in the Mediterranean (Antunović *et al*., 2020). The importance of breeding goats in karst areas is also reflected in the cleaning of the terrain, as goats are called "terrain cleaners", which ultimately reduces the risk of fires starting and spreading. In the Republic of Croatia, in the period from 2014 to 2018, the number of goats in organic farming increased by 170.55%, and the production of goat meat by 750.0% (Antunović *et al*., 2020). The above data show the expansion of goat breeding and goat meat production in this area. Perspective of goat production in future should be more significant especially in hilly-mountainous regions, also in certain low land regions where soil quality is good only for pastures and meadows and considering production and labour potentials present on private farms it has certain advantages over other branches of livestock production (Žujović *et al*., 2005). Goat meat is a healthier alternative compared with other red meats. It has low saturated fatty acids and cholesterol (Anaeto *et al*., 2010). Goat meat has a significant role in human nutrition because it contains essential amino acids such as lysine, threonine and tryptophan (Ivanović *et al*., 2016). Based on greater nutritional value and greater unsaturated fatty acid to saturated fatty acid ratio, goat meat has the potential for improving human health and reducing obesity risk and related metabolic diseases (Mazinani & Rude, 2020). Flavor and aroma are complex attributes of goat meat. These sensory attributes are affected by species, age, fatness, and anatomical location, gender, diet and method of cooking (Webb, 2014). Aroma represents the overall perception of taste and smell. Taste is mainly associated with non-volatile compounds, such as free amino acids and small peptides that are formed at the end of the production process, while the smell is associated with the formation of volatile compounds with important aromatic properties (Marušić, 2013). The most important processes that create compounds with a direct impact on the taste and aroma of cured meat products are proteolysis and lipolysis, which involve the breakdown of proteins and lipids. Proteins and lipids constitute the major chemical components of meat and are the main substrates of action of the muscle enzyme systems. Throughout the drying stage, there exists a noticeable enzyme activity that will result in the generation of flavor precursors, such as amino acids and peptides. These precursors will contribute to the generation of flavor volatiles via the Strecker degradation system and the formation of Maillard reaction products (Flores *et al*., 1997). These changes give rise to volatile compounds such as aldehydes, carboxylic acids, alcohols, ketones, esters, sulphur and nitrogen compounds, terpenes, alkanes and alkenes, aromatic and cyclic hydrocarbons (Jerković *et al*., 2007). Smoked products also contain phenols, which are produced by pyrolysis of lignin. In addition to the positive effect of the smoking process and the large number of useful compounds that are created by burning wood, harmful components are also created, which include Polycyclic Aromatic Hydrocarbons, i.e. PAHs. Polycyclic aromatic hydrocarbons (PAHs) comprise the largest class of chemical compounds, containing two or more fused aromatic rings made up of carbon and hydrogen atoms, known to be genotoxic agents (Ciecierska & Obiedzinski, 2007). About 660 different compounds belong to the PAH group (Đinović *et al*., 2009; Jira *et al*., 2013; Pöhlmann *et al*., 2013). These are components that have a harmful effect on the human body because certain members of this group have been found to be carcinogenic or potentially carcinogenic. The volatile compounds generated in dry-cured meat products to the final aroma depending on several parameters: concentration, odour threshold and the interaction with the food matrix (Toldrá *et al*., 2009). The production of dried goat meat is related to the wider Mediterranean area. To date, it can be found in the southern parts of France and in Corsica, Sardinia and southern Italy, and Greece (Krvavica, 2010). In Bosnia and Herzegovina, the use of young goat meat is mainly reduced to roasted young goatling (spit or brick grill). The meat of adult heads is used for the production of goat "stelja" in the areas of central and northern Bosnia, kastradina in Herzegovina and dried goat whose production is traditionally present in southeastern Bosnia (Ganić *et al*., 2013). The wider area of the municipality of Stolac is characterized by a long tradition in the production of the well-known "Herzegovina dry smoked goat meat". The peculiarity of the Mediterranean climate and plant cover, the specificity of the smell and aroma of meat, as well as the production technology, gives this traditional meat product exceptional sensory properties (Ganić *et al*., 2019; 2021). According to the Regulation of ground meat, meat preparations and meat products (Official Gazette of B&H No. 82/13), Herzegovinian dry smoked goat meat is classified as a preserved dried meat product where the moisture content must be less than 60%, water activity less than 0.93 and it must be stored at temperatures up to 15 ℃. The special feature of this traditional product, along with others, is the special method of drying and smoking. Namely, drying and smoking are traditionally done on Hrgud Mountain. There are a few villages that are still inhabited on the mountain. Residents who still live in traditional mountain houses are made of stone, and their main source of income is agriculture, that is, animal husbandry. In addition, the rare inhabitants, who still live in these traditional mountain villages, are known to produce the traditional "Herzegovinian dry smoked goat meat - plaha". In the past, according to oral traditions, up to 200 plahas, which were produced in the surrounding villages, were sold weekly on the Stolac market. Nowadays, in the wider locality of the municipality of Stolac, there is only one meat processor engaged in the production of "Herzegovinian dry smoked goat meat". Its annual production is around 150 "steljas", which are mainly placed on the Sarajevo market (market places). Nowadays, with the changes in consumer habits, goat meat is increasingly in demand on the market and is considered one of the best specialties, precisely because of its high quality and characteristic taste and smell. Accordingly, the examination of the quality of processed products and traditional goat meat products should be the subject of more research. Considering that Herzegovina dry goat meat is an autochthonous cured meat product that has not been sufficiently researched so far and is characterized by long-term traditional production, defining quality parameters of the final product would greatly contribute to the production and recognition of this product on the market. No significant research on the quality of goat meat and goat meat products has been conducted in Bosnia and Herzegovina. Therefore, the aim of this study was, for the first time, to identify volatile compounds of the aroma of Herzegovinian dry smoked goat meat. The importance of the research is reflected in the possibility of characterizing this product because some authors state that it can be performed based on isolated volatile substances. Also, the obtained research results can serve as a basis for the standardization of the production technology of this product. In the future, Herzegovina dry goat meat can represent an exceptional tourist brand that would first and foremost contribute to the development and promotion of rural areas of Bosnia and Herzegovina.

MATERIAL AND METHODS

Material. Herzegovinian dry smoked goat meat is a traditional meat product characteristic of the area of East Herzegovina, especially for the municipality of Stolac. The meat processor, which produces this meat product, owns its property on Hrgud mountain, where the animals stay all year round. Bucks intended for the production of "Herzegovinian dry smoked goat meat" are grazed exclusively on pasture, without the addition of a concentrated meal. Goats are bred in this area with a specific flora, which gives special properties to the meat. The production of this traditional meat product is characteristic only for the period from December to February. It is produced only from castrated male goats older than three years. It is known that bucks in the breeding season have a specific unpleasant smell, which originates from sex hormones. By slaughtering non-castrated animals, the smell is transferred to the meat to a significant extent, which makes it sensory unacceptable. That is why it is necessary to castrate male throats. Castration is a surgical procedure that removes the gonads (orchiectomy). For the purpose of this research, for the production of Herzegovinian dry smoked goat meat, five heads were used. Standard technology involves the following phases: bucks selection, slaughter, head and skin separation, evisceration, carcass cooling, deboning and processing of raw “stelja”, salting, then drying and smoking. The bleeding of the animal is done in the traditional way so that the neck veins are cut with a knife at the level of the atlanto-occipital joint. After the bleeding ends, the head and skin are separated. The processing of raw „stelja“ and boning begins by making an incision on the part of the sternum towards the spinal column and neck. Then the meat is separated from the bones by cutting the musculature and the pelvic symphysis (*Symphysis pelvis*). The next phase involves a cut from the cranial side of the hind limbs with the separated musculature of the femoral (*Regio femoris*) and crural region (*Regio cruris*), whereby the skeleton is finally separated from the musculature. The shoulders remain within the trunk, with the shoulder blade (*Scapula*) and the upper arm bone (*Humerus*) being deboned, while the forearm bone (*Radius*) remains within the muscle tissue. To remove the shoulder blade and the upper arm bone, an incision is made on the medial side and the *capsule articularis* is opened, whereby *cavitas glenoidalis* (cavity) and *caput humeri* (head) are observed. After slaughtering the animals and primary processing of the carcasses, the meat is manually salted with coarse sea salt. Salting lasts from three to four days. The meat is then dried and smoked. The smoking procedure lasts from 15 to 20 days and is performed intermittently. The meat is dried and smoked for two days, and then the smoking is stopped. Apart from smoking and drying, all technological phases were performed in the slaughterhouse "Obradović" Stolac. Smoking and drying of meat is done in traditional stone smokehouses on the mountain Hrgud (above 1000 m). Ideal conditions for drying and smoking meat on Mountain Hrgud are the result of a characteristic climate characterized by the influence of the Mediterranean but at the same time the presence of continental currents. The relatively high altitude results very often in strong currents, which have exceptional dehydrating properties. That's why the smoking of meat takes place very briefly without intense smoking and with frequent breaks. After the technological process of production, confectioning was performed in eight parts (Figure 1).

Figure 1. Anatomical parts of Herzegovinian dry smoked goat meat (1. neck, 2. sirloin, 3. leg, 4. loin, 5. flank, 6. breast, 7. shoulder, 8. hindshank)

Methods. Volatile compounds were isolated by microextraction in the solid phase (HS-SPME) and analysed by gas chromatographic mass spectrometry (GC-MS) using a gas chromatograph 7890A (GC) associated with the mass spectrometer 5975C (MS) (Agilent Technologies, Santa Clara, CA, USA). After defrosting, each sample was homogenized in a commercial homogenizer of food supplemented with a saturated NaCl solution and prepared according to Krvavica & Milak, (2017). After homogenization, 10 mL of the sample was quantitatively transferred to a glass vial of 20 mL in which a stirring magnet was placed, which was then sealed with a PTEF septum. For extraction, SPME was coated with DVB/Carboxen/PDMS filler (divinylbenzene/carboxy/poly-dimethylsiloxane) thickness of 50/30 μm and length 2 cm, which was conditioned for 2 min at 240 °C prior to extraction. A glass vial with a sample was placed in a water bath at 40 °C, and the sample was conditioned for 15 min at the same temperature before the fibre was inserted. The extraction was carried out for 180 min with constant stirring. The fibre was extracted from the vial upon completion of the extraction and immediately injected into the gas chromatographic injector. The injector temperature in splitless mode was 250 °C and the desorption time was 2 min. The detector temperature was set at 250 °C and the transfer line temperature at 280 °C. The helium flow rate of the carrier gas was 1.0 mL min^{-1}, and the separation of the volatile compounds was performed using DB-5ms, 30 m × 0.25 mm capillary column thickness 0.25 μm (Agilent Technologies, Santa Clara, CA, USA), in the following temperature program: initial temperature 40 °C, 10 min; 200 °C, 5 °C min^{-1}; 250 °C, 20 °C min^{-1} for 5 min. Mass spectra were obtained in Electron Ionization (EI) mode (Agilent Technologies, USA) at 70 eV at a scan rate of 1 scan per scan range of 50 to 450 m z^{-1} and the ion source temperature and mass analyser were 230 °C and 150 °C. The obtained spectra were subsequently analysed using the Enhanced ChemStation Data Analysis program, comparing the obtained mass spectra with the spectra contained in NIST 08 (US National Institute of Standards and Technology) and Wiley 8th Ed. mass spectrum databases. The identification of the volatile compounds was performed on the basis of a comparison of mass spectra, which were then confirmed by retention indexes (RI) using standard compounds for the selected volatile substances. For calibration RI, a mixture of alkane C8-C20 and pure hexane and heptane standard (Sigma-Aldrich, St. Louis, MO, USA) were analysed according to the same GC-MS program as well as the analysed samples. As the RI database, the NIST 08 mass spectrum database was used. The obtained data are shown as % of the surface area of each volatile compound in relation to the total surface of each peak. Each sample was analyzed in two replicates.

Statistical analyses. All determinations data were reported as mean ± standard deviation. For the correlation and presentation of the results multivariate data analysis was used - analysis of the basic components or PCA analysis. Statistical analyses were performed using Past software 3.15 (Hammer *et al.*, 2001).

RESULTS AND DISCUSSION

A total of 97 volatile aroma compounds of Herzegovinian dry smoked goat meat were found by gas chromatographic–mass spectrometry (GC–MS). The results of the analysis of volatile compounds are presented in Table 1. Volatile compounds belonged to several classes of chemicals: aldehydes (8), alcohols (5), ketones (9), esters and lactones (8), hydrocarbons (2), phenols (30), aromatic hydrocarbons (24), acids (7), furans (2) and terpenes (2). Chemical groups identified in Herzegovinian dry smoked goat meat were: phenols (75.12%), aromatic hydrocarbons (17.47%), aldehydes (3.89%), acids (3.55%), alcohols (2.07%), ketones (1.60%), furans (0.36%), hydrocarbons (0.29%), terpenes (0.19%), esters and lactones (0.06%). As presented in Table 1., the most abundant compounds found in analyzed samples were phenols, aromatic hydrocarbons and aldehydes. Phenols were the most represented group of volatile aroma compounds in the tested samples. A high proportion of phenolic compounds is expected since they come from smoke and the technology of production of Herzegovinian dry smoked goat meat implies the smoking process. Also, phenolic compounds were one of the most represented groups in smoked meat products such as dalmatian dry-cured bacon (Krvavica & Milak, 2017), dalmatian dry-cured loin (Krvavica *et al*., 2018), slavonian kulen (Marušić Radovčić *et al*., 2015), dalmatian and drina dry-cured hams (Petričević *et al*., 2018). Phenols and phenolic derivated volatiles were formed primarily due to pyrolysis and oxidation of lignin, at comparatively low temperature (200–400 °C) (Marušić Radovčić *et al*., 2016). Phenolic compounds (phenols and metoxyphenols) are mainly responsible for the unique aroma and taste of smoked products. Phenols have low threshold value so their impact on the flavour of smoked products is significant (Petričević *et al*., 2018). Phenolic compounds have heavy, pungent, burnt, cresolic and smoky notes (Górska *et al*., 2017). They have an antimicrobial and antioxidative effect (Marušić Radovčić *et al*., 2019). The sample of leg part had the highest phenol content (83.03%) and the lowest was found in loin sample (68.10%). The most abundant phenols were: p-cresol (6.60-13.25%), creosol (4.73-10.71%), 2,6-dimethoxyphenol (4.17-10.49%), phenol (5.99-11.02%), 4-ethyl-2-methoxyphenol (0.00-10.00%) and 2-methylphenol (4.93-7.68%). A total of 30 phenols were identified in the tested samples, and 28 of them were found in the flank sample. The lowest number of phenols identified was in the leg sample (19), even though it had the highest content of this group of compounds. The highest p-cresol and creosol contents were found in the leg sample (13.25%; 10.71%), phenol in the sirloin sample (11.02%), and 2,6-dimethoxyphenol in the hindshank sample (10.49%). Ivanović *et al*., (2016) found three phenols in smoked goat ham phenol, 2-methylphenol and 2-methoxyphenol, while Ivanović *et al*., (2014) found only 2-methylphenol and 2-methoxyphenol in the same product. A much lower content of 4-methylphenol was found in salted and ripened goat thigh (0.08%) in a study by Paleari *et al*., (2008). In their study, Hierro *et al*., (2004) identified the following phenolic compounds in goat cecina: phenol, 2-methylphenol, 4-methylphenol, 2-methoxyphenol, and 4-methyl-2-methoxyphenol. In sheep ham in the study of Stojković *et al*., (2015) 2-methoxyphenol, 4-methyl-2-methoxyphenol and 4-ethyl-2-methoxyphenol were identified from this group. Aromatic carbohydrates were the second most common group of volatile compounds of Herzegovinian dry smoked goat meat, which, like phenols, originate from smoke. Aromatic hydrocarbons may play an important role on the aroma of dry cured meat products due to their low odor threshold (Hazar *et al*., 2019). The most represented from this group were methoxy-phenyl-oxime (2.51-6.54%), naphthalene (3.90-5.07%) and 2-methylnaphthalene (0.00-1.97%). The highest content of aromatic hydrocarbons was found in the breast sample (20.83%) and the lowest in the leg sample (10.77%). The breast sample had the highest fat content (50.35%) and the lowest moisture content (12.61%) compared to the other examined samples in the research by Ganić *et al*., (2022). A total of 24 compounds from this group were identified in the examined samples, and in the comparison of different anatomical regions, the largest number of compounds from this group was identified in the flank sample (19). The neck sample had the highest content of naphthalene (5.07%) and 2-methylnaphthalene (1.97%), while the loin sample had a characteristic content of methoxy-phenyl-oxime (6.54%). Benzene, methylbenzene and ethylbenzene have been identified as aromatic compounds in smoked goat ham (Ivanović *et al*., 2014; 2016) and goat cecina (Hierro *et al*., 2004). Metoxy-phenyl-oxime was identified in lika lamb (0.11%) (Krvavica *et al*., 2015a), dalmatian lamb (1.81%) (Krvavica *et al*., 2015b), pag lamb (2.67%) (Krvavica *et al*., 2015c), cres lamb (3.12%) (Krvavica *et al*., 2016) and kupres lamb (2.77%) (Krvavica *et al*., 2020). The third most common group of volatile compounds of Herzegovinian dry smoked goat meat was aldehydes, which have a significant impact on the aroma of smoked products due to the low threshold of sensory detection. Straight-chain aliphatic aldehydes are typical products of lipid oxidation and could arise from the oxidation of unsaturated fatty acids (Sha *et al*., 2016). Oxidative deamination via Strecker degradation is a reaction where branched aldehydes are formed (Marušić Radovčić *et al*., 2016). The highest proportion of aldehydes was found in the neck sample (5.19%), while the smallest share in the leg sample (2.75%). In the research of Ganić *et al*., (2022) it was determined that the neck sample had the highest NaCl content (9.99%), and the leg sample had the lowest content (5.55%). In the same research, the highest value of the peroxide number was recorded in the neck sample (4.65 mmol/kg), which implies that NaCl is a promoter of lipolysis. In the neck, loin and breast samples, 6 out of 8 aldehydes were identified. The most common aldehyde in the test samples was nonanal (1.85-4.25%). In the comparison of different anatomical regions of the Herzegovinian dry smoked goat meat, the highest content of nonanal was found in the neck sample (4.25%). Nonanal contributes to flavour with sweet and fruity aroma (Marušić *et al*., 2014), and comes from the oxidation of oleic acid (García-González *et al*., 2013). Nonanal was found in smoked goat ham (Ivanović *et al*., 2014; 2016), goat cecina (Hierro *et al*., 2004) and in salted and ripened goat thigh (Paleari *et al*., 2008). Benzaldehyde and 2-furancarboxaldehyde, 5-methyl were identified in the tested samples in smaller amounts. The reaction between amino acids also produces aromatic aldehydes such as benzaldehyde, although the latter can also be formed during lipid oxidation. It contributes substantially to dry-cured meat products aroma with a bitter almond sensory note because of its low odor threshold (García-González *et al*., 2013). The highest content of benzaldehyde was found in the sirloin sample (0.45%). Aldehyde 2-furancarboxaldehyde, 5-methyl contributes to the aroma of dried meat products with notes of almonds, burnt sugar, and caramel, and the highest content was found in the neck sample (0.27%). The acids are probably products of the oxidation of aldehydes, though they may also be originated from enzymatic lipolysis (García-González *et al*., 2013). Seven acids were identified in the samples of Herzegovinian dry smoked goat meat, and the most common were octadecanoic acid (0.08-4.43%) and n-hexadecanoic acid (0.03-5.91%). Out of a total of seven identified acids, six of them were found in the hindshank sample. The highest acid content was found in the loin sample (9.97%), and the lowest in the leg sample (0.25%). In the loin sample, n-hexadecanoic acid (5.91%) and octadecanoic acid (3.38%) were the most abundant. In addition to the above, a high acid content was recorded in the shoulder sample (9.95%), and the most abundant were oleic acid (4.35%), n-hexadecanoic acid (2.63%) and octadecanoic acid (2.40%). Straight chain alcohols come from polyunsaturated fatty acid oxidation, although low molecular weight ones most likely arise from microbial fermentation. The methyl branched alcohols can also be derived from the Strecker degradation of amino acids (Muriel *et al*., 2004). Alcohols contribute to ham flavor with herbaceous, woody and fatty notes (García-González *et al*., 2013). Alcohols have a low odour threshold, so they are crucial contributors to the aroma of meat products (Lorenzo *et al*., 2013). The largest share of alcohol was in the sirloin sample (4.36%). A total of five alcohols were identified in the mentioned sample. Other examined samples had lower alcohol content and a smaller number of identified alcohol. In the samples of Herzegovinian dry smoked goat meat, out of a total of five identified alcohols, the most represented was 2-furanmethanol (0.58-1.88%). In a comparison of different anatomical regions, the highest alcohol content was recorded in the leg sample (1.88%). The compound 2-furanmethanol, which exhibited burnt meat and vitamin-like aromas, has several suggested formation pathways such as the Maillard reaction, thermal degradation during smoking, and the deamination and dehydration of Amadori products during heating (Pham *et al*., 2008; Górska *et al*., 2017). It was also identified in polish dry-cured loin (Górska *et al*., 2017), in dalmatian dry-cured loin (0.27%) (Krvavica *et al*., 2018), in slavonian kulen (0.70%) (Marušić Radovčić *et al*., 2015), and in kazakh dry-cured beef (Sha *et al*., 2017). Ketones can be produced both lipid and by microbiological metabolism. They are considered to have a great influence on the aroma of meat and meat products, and they have a peculiar aroma, such as ethereal, butter, spicy notes or blue cheese notes (Lorenzo *et al*., 2013). Nine ketones were identified in the examined samples, and the most represented were 3-ethyl-2-hydroxy-2-cyclopenten-1-one (0.00-1.09%), 1-methylindan-2-one (0.00-0.63%) and 1-(2-furanyl) ethanone (0.11-0.56%). In the comparison of samples from different anatomical regions, the loin sample had the highest ketone content (1.97%). Six out of a total of nine ketones were identified in the leg and hindshank samples. The sirloin sample had a characteristic content of 3-ethyl-2-hydroxy-2-cyclopenten-1-one (1.09%), the flank sample had the highest content of 2-methyl-2-cyclopenten-1-one (0.75%), and the shoulder sample had the highest content of 1-methylindan-2-one (0.63%) compared to the other tested samples. Furans, hydrocarbons, terpenes, esters and lactones were found in smaller values in the examined samples. Furans originate from smoke and Maillard reactions. Furan derivatives give aroma notes of caramel, sweet, burnt and sugar notes (Marušić Radovčić *et al.*, 2015). Two compounds from this group were identified in the tested samples. Sirloin (0.67%) and breast (0.64%) samples had the highest furan content. Two compounds from the group of hydrocarbons were identified in the test samples of Herzegovinian dry smoked goat meat. In the leg sample, 1H-indene, 1-methylene (2.26%) was identified, and in the sirloin sample, 1-tetracosene (0.08%). The lower content of hydrocarbons in the examined samples is probably due to the higher content of phenols and aromatic hydrocarbons. In addition to the small content in the examined samples, their influence on the aroma is not significant because they have a high sensory detection threshold (Akköse *et al.*, 2017; Lorenzo, 2014; Lorenzo i Purriños, 2013; Kaban, 2009). Two terpenes were identified in the examined samples. The neck sample had the highest terpene content (0.27%), which makes up the limonene content. Terpenes in meat products come from spices that are added during the production process, while some such as limonene may be present as a result of the diet. Namely, terpenes are normal constituents of the non-saponifying fraction of vegetable oils, which means that they originate from food and accumulate in the body of the animal (Sabio *et al.*, 1998). Namely, during the production of Herzegovinian dry smoked goat meat, no spices were used, which implies that this group of compounds originates from animal nutrition.

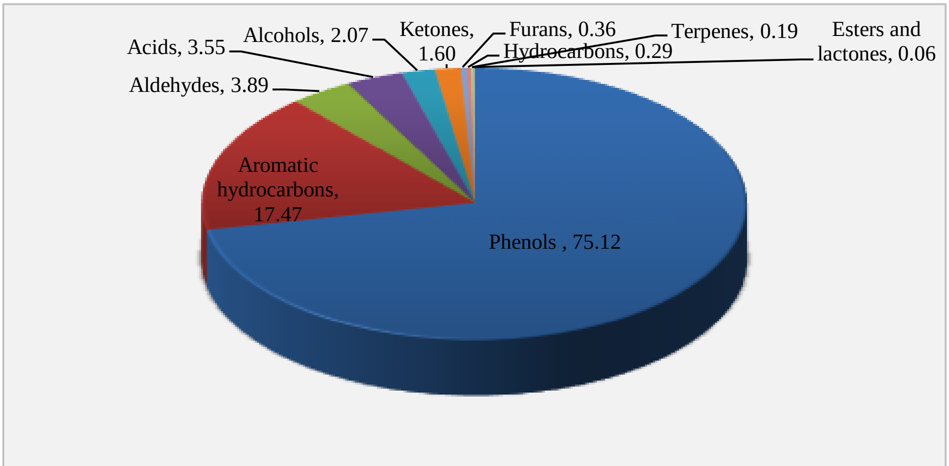

Figure 2. Volatile compounds of Herzegovinian dry smoked goat meat (% of the total peak area)

Seven esters and one lactone were identified in the examined samples. This group of volatile compounds was determined in small quantities. Ester compounds are formed by esterification of carboxylic acids and alcohols (Mateo & Zumalacárregui, 1996; Kaban, 2013). They have a very low threshold of sensory detection (Wu *et al*., 2015), and their contribution to the aroma of meat products depends on the length of the chain. Esters formed from short-chain acids have fruity notes; while esters with long-chain acids have a slight fatty odour (Pugliese i sar., 2015). Lactones are cyclic esters formed by the intermolecular reaction of the carboxyl group and the OH-group of hydroxycarboxylic acid (Velagić-Habul, 2010). The highest content of esters and lactones had the sirloin sample (0.29%). In the mentioned sample, 5 of the total 7 esters and one lactone were identified, while in the other samples, the presence of one or none of the compounds from this group was recorded.

Principal component analysis of the volatile compounds

The analysis of the main components was performed on the basis of a correlation matrix in which ten parameters were included for eight samples of Herzegovinian dry smoked goat meat. For the analysis of the main components groups of volatile compounds, namely aldehydes, alcohols, ketones, esters and lactones, hydrocarbons, phenols, aromatic hydrocarbons, acids, furans and terpenes were used as variables. The first two components that are the result of testing the above parameters of samples of Herzegovinian dry smoked goat meat contained 66.15% of the total variance, the first 42.92% and the second 23.23%.

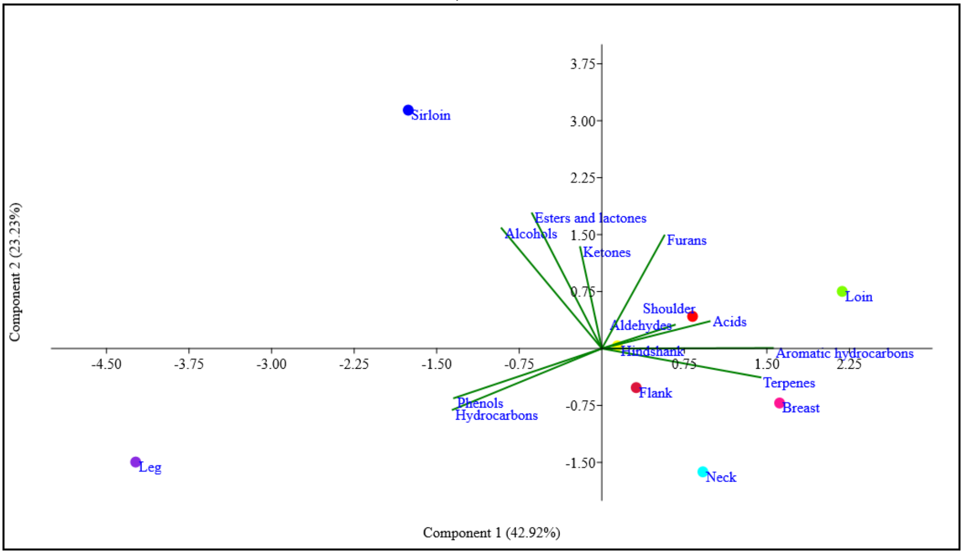

Figure 3. Plot of principal component analysis of the volatile compounds of Herzegovinian dry smoked goat meat

From the results shown in Figure 3, it can be seen that the alcohol, ketone, ester and lactone contents achieved a significant positive correlation. A positive correlation was found between the content of terpene, aldehyde, aromatic hydrocarbons and acids. The hydrocarbon content achieved a significant positive correlation with phenol content. From the presented graph it can be seen that the aromatic hydrocarbons content was characteristic for the breast sample, while the alcohol, ester and lactone content for the sirloin sample. The phenol and hydrocarbon content were characteristic for the leg sample and the acid content for the loin sample. The hindshank sample had characteristic aldehyde content. In contrast, the content of terpene was characteristic of the neck and loin samples.

Table 1. Volatile compounds of the Herzegovinian dry smoked goat meat aroma (% of the total peak area)

RI	VOLATILE COMPOUND	Total area (%)								
		Neck	Sirloin	Leg	Loin	Flank	Breast	Shoulder	Hindshank	Identif.
ALDEHYDES		**5.19±1.20**	**4.50 ±0.38**	**2.75 ±0.58**	**4.01 ±0.24**	**3.52 ±0.75**	**4.15 ±0.36**	**2.96 ±0.32**	**4.03 ±0.32**	
795.80	Hexanal	0.07±0.10	nd	nd	nd	nd	nd	nd	nd	MS, RI
895.24	Heptanal	0.25±0.05	nd	nd	0.08 ±0.07	nd	0.21 ±0.07	nd	nd	MS, RI
955.28	Benzaldehyde	0.30±0.03	0.45 ±0.06	0.36 ±0.01	0.25 ±0.14	0.21 ±0.05	0.21 ±0.09	0.29± 0.10	0.28±0.02	MS, RI
961.55	2-Furancarboxaldehyde, 5-methyl	0.27±0.10	0.15 ±0.19	nd	0.08 ±0.07	nd	0.18 ±0.04	0.09 ±0.12	nd	MS, RI
1005.84	1H-Pyrrole-2-carboxaldehyde	nd	0.07 ±0.09	nd	0.09 ±0.11	0.11 ±0.07	0.07 ±0.08	0.13 ±0.17	nd	MS, RI
1092.04	Nonanal	4.25±0.85	3.75 ±0.70	1.85 ±0.60	3.24 ±0.06	3.01 ±0.60	3.42 ±0.32	2.45 ±0.50	3.00±0.09	MS, RI
1465.15	Benzaldehyde, 2,5-dimethoxy	nd	0.09 ±0.11	nd	nd	nd	nd	nd	nd	MS, RI
1784.51	Hexadecanal	0.05±0.07	nd	0.54 ±0.02	0.27 ±0.03	0.19 ±0.01	0.07 ±0.08	nd	0.75±0.21	MS, RI
ALCOHOLS		**1.71±0.21**	**4.36 ±3.32**	**2.2 0±0.47**	**1.49 ±0.06**	**1.95 ±0.26**	**1.04 ±0.00**	**1.60 ±0.31**	**2.24±0.24**	
865.36	2-Furanmethanol	0.99±0.14	1.56 ±0.72	1.88 ±0.42	0.94 ±0.58	1.30 ±0.07	0.58 ±0.07	1.27 ±0.74	1.79±0.10	MS, RI
941.30	2-Propanol, 1-butoxy	0.18±0.25	0.18 ±0.25	0.33 ±0.03	0.22 ±0.02	0.18 ±0.23	nd	nd	0.10±0.15	MS, RI
1099.34	Maltol	0.54±0.10	2.33 ±2.48	nd	0.33 ±0.42	0.48 ±0.09	0.46 ±0.06	0.33 ±0.43	0.35±0.48	MS, RI
1571.27	2-Tetradecanol	nd	0.21 ±0.27	nd	nd	nd	nd	nd	nd	MS, RI
1648.82	1-Tetradecanol	nd	0.09 ±0.12	nd	nd	nd	nd	nd	nd	MS, RI
KETONES		**1.14±0.31**	**1.78 ±0.08**	**1.63 ±1.05**	**1.97 ±0.09**	**1.61 ±0.43**	**1.17 ±0.50**	**1.85 ±1.47**	**1.66±1.22**	
796.02	1-Hydroxy-2-butanone	nd	nd	0.01 ±0.01	nd	nd	nd	0.01 ±0.01	0.01±0.01	MS, RI
896.16	2-Cyclopenten-1-one, 2-methyl	nd	0.22 ±0.30	0.17 ±0.05	0.15 ±0.19	0.75 ±0.47	nd	0.09 ±0.12	0.17±0.07	MS, RI
902.39	Ethanone, 1-(2-furanyl)	0.15±0.20	0.23 ±0.29	0.37 ±0.19	0.46 ±0.15	0.39 ±0.05	0.11 ±0.10	0.46 ±0.19	0.43±0.10	MS, RI
952.18	2(3H)-Furanone, dihydro-5-methyl	nd	nd	0.02 ±0.03	nd	nd	nd	nd	nd	MS, RI

RI	VOLATILE COMPOUND	Total area (%)								
		Neck	Sirloin	Leg	Loin	Flank	Breast	Shoulder	Hindshank	Identif.
1106.53	2-Cyclopenten-1-one, 3-ethyl-2-hydroxy	0.40±0.52	1.09 ±0.22	0.47 ±0.62	nd	nd	0.68 ±0.90	0.66 ±0.89	nd	MS, RI
1188.58	1-Methylindan-2-one	0.44±0.60	nd	nd	0.51 ±0.09	0.47 ±0.01	0.38 ±0.50	0.63 ±0.49	0.43±0.60	MS, RI
1192.59	2-Hydroxy-3-propyl-2-cyclopenten-1-one	0.15±0.20	nd	nd	0.34 ±0.01	nd	nd	nd	nd	MS, RI
1286.30	1H-Inden-1-one, 2,3-dihydro-2-methyl	nd	0.25 ±0.32	0.59 ±0.24	0.51 ±0.09	nd	nd	nd	0.42±0.58	MS, RI
1907.05	Cyclopentadecanone, 2-hydroxy	nd	nd	nd	nd	nd	nd	nd	0.20±0.03	MS, RI
ESTERS and LACTONES		**0.02±0.02**	**0.29 ±0.00**	**0.05 ±0.06**	**0.02 ±0.03**	**0.00 ±0.00**	**0.00 ±0.00**	**0.11 ±0.04**	**0.00±0.00**	
808.79	Acetic acid, butyl ester	nd	0.13 ±0.18	nd	nd	nd	nd	nd	nd	MS, RI
973.18	2H-Pyran-2-one	nd	0.07 ±0.09	nd	0.02 ±0.03	nd	nd	nd	nd	MS, RI
> 2000	Octadecanoic acid, 2-propenyl ester	nd	0.01 ±0.01	nd	nd	nd	nd	nd	nd	MS, RI
> 2000	trans-13-Octadecenoic acid, methyl ester	nd	nd	nd	nd	nd	nd	0.11 ±0.03	nd	MS, RI
> 2000	Carbonic acid, decyl hexadecyl ester	0.02±0.02	nd	nd	nd	nd	nd	nd	nd	MS, RI
> 2000	Hexadecanoic acid, butyl ester	nd	0.05 ±0.06	0.05 ±0.06	nd	nd	nd	nd	nd	MS, RI
> 2000	Methyl-16-acetoxyheptadecanoate	nd	0.02 ±0.03	nd	nd	nd	nd	nd	nd	MS, RI
> 2000	Heneicosanoic acid, butyl ester	nd	0.01 ±0.01	nd	nd	nd	nd	nd	nd	MS, RI
HYDROCARBONS		**0.00±0.00**	**0.08 ±0.00**	**2.26 ±3.17**	**0.00 ±0.00**	**0.00 ±0.00**	**0.00 ±0.00**	**0.00 ±0.00**	**0.00±0.00**	
1167.02	1H-Indene, 1-methylene	nd	nd	2.26 ±3.17	nd	nd	nd	nd	nd	MS, RI
> 2000	1-Tetracosene	nd	0.08 ±0.00	nd	nd	nd	nd	nd	nd	MS, RI
PHENOLS		**76.54±1.12**	**77.26 ±7.78**	**83.03 ±1.69**	**68.10 ±16.21**	**77.98 ±0.93**	**73.33 ±3.11**	**69.62 ±13.07**	**75.13 ±2.53**	
984.15	Phenol	7.94±0.20	11.02 ±1.75	9.71 ±0.02	5.99 ±3.71	8.90 ±0.17	6.15 ±2.23	7.60 ±4.31	6.54±0.03	MS, RI
1051.04	Phenol, 2-methyl	5.46±0.91	6.68 ±2.14	7.68 ±1.45	4.93 ±0.98	5.50 ±0.23	5.34 ±0.48	5.95 ±1.58	7.11±0.04	MS, RI
1072.20	p-Cresol/ 4-methyl phenol	11.10±0.53	12.79 ±2.05	13.25 ±1.16	9.87 ±1.90	10.70 ±0.22	11.57 ±0.13	11.24 ±1.93	6.60±9.13	MS, RI

RI	VOLATILE COMPOUND	Total area (%)								
		Neck	Sirloin	Leg	Loin	Flank	Breast	Shoulder	Hindshank	Identif.
1083.66	Phenol, 4-methoxy-3-methy	0.61±0.80	nd	nd	nd	nd	nd	nd	nd	MS, RI
1106.21	Hydrazine, (3-fluorophenyl)	nd	nd	0.57 ±0.75	0.42 ±0.58	1.12 ±0.43	nd	nd	1.00±0.08	MS, RI
1128.74	Phenol, 2-ethyl	1.43±0.09	1.10 ±0.69	1.54 ±0.05	0.96 ±0.48	1.18 ±0.07	1.03 ±0.26	1.13 ±0.48	1.42±0.06	MS, RI
1139.58	Phenol, 2,3-dimethyl-	5.18±0.49	nd	5.58 ±0.01	nd	2.04 ±2.68	3.41 ±1.88	1.97 ±2.67	2.41±3.33	MS, RI
1139.88	Phenol, 2,5-dimethy	nd	2.43 ±3.43	nd	nd	1.95 ±2.61	2.53 ±3.35	2.40 ±3.27	2.55±3.50	MS, RI
1157.19	Phenol, 4-ethyl	nd	nd	0.6 8 ±0.95	nd	1.06 ±0.05	nd	0.62 ±0.85	1.26±0.07	MS, RI
1159.58	Phenol, 3,4-dimethyl-	5.41±0.05	2.50 ±3.15	4.86 ±0.60	4.02 ±0.08	3.45 ±0.01	5.18 ±0.06	4.12 ±0.24	4.20±0.34	MS, RI
1176.13	2-Methoxy-5-methylphenol	5.41±5.20	9.25 ±2.63	10.71 ±1.19	7.56 ±1.83	8.15 ±0.64	1.15 ±0.03	1.22 ±0.17	1.40±0.02	MS, RI
1179.34	Creosol/Phenol, 2-methoxy-4-methyl	4.73±0.29	9.25 ±0.09	10.71 ±0.62	7.56 ±0.80	8.15 ±0.03	8.07 ±0.48	8.20 ±0.08	10.20±0.36	MS, RI
1198.84	Phenol, 2,4,6-trimethyl	0.22±0.29	0.43 ±0.09	1.01 ±0.63	0.58 ±0.80	0.38 ±0.03	0.78 ±0.50	0.39 ±0.08	0.74±0.36	MS, RI
1206.42	Phenol, 2-propyl	0.11±0.14	0.10 ±0.12	nd	0.11 ±0.15	0.09 ±0.11	nd	nd	nd	MS, RI
1221.51	Phenol, 2-ethyl-5-methyl	nd	0.21 ±0.29	nd	0.84 ±0.54	0.31 ±0.01	0.17 ±0.22	nd	0.19±0.36	MS, RI
1232.32	Phenol, 2-ethyl-6-methyl	1.42±1.96	1.36 ±0.31	nd	0.84 ±0.54	1.38 ±0.03	nd	0.34 ±0.04	0.92±0.75	MS, RI
1233.70	Phenol, 3-ethyl-5-methyl	1.02±0.22	0.19 ±0.24	nd	1.50 ±0.39	0.71 ±0.90	0.31 ±0.41	1.03 ±0.13	1.50±0.43	MS, RI
1238.18	Phenol, 2-ethyl-4-methyl	nd	nd	0.81 ±1.08	nd	1.17 ±0.25	0.89 ±1.18	0.75 ±1.02	nd	MS, RI
1251.47	Phenol, 2,3,5-trimethyl	1,03±0,03	nd	0,98 ±0,01	0,89 ±0,17	0,79 ±0,03	0,91 ±0,05	0,88 ±0,08	0,55±0,12	MS, RI
1251.81	4-Isopropylphenol	nd	nd	1.33 ±1.77	nd	0.50 ±0.67	nd	nd	0.95±0.99	MS, RI
1263.56	Phenol, 4-ethyl-2-methoxy	9.33±0.27	10.00 ±1.45	nd	7.30 ±1.50	7.56 ±0.62	8.43 ±0.39	8.55 ±0.73	9.43±0.25	MS, RI
1295.05	2-Methoxy-4-vinylphenol	2.80±0.06	2.46 ±0.39	nd	1.25 ±1.73	2.12 ±0.10	2.95 ±0.18	1.26 ±1.72	1.78±0.51	MS, RI
1304.78	Phenol, 5-methoxy-2,3,4-trimethyl	nd	nd	0.74 ±0.01	0.23 ±0.32	0.20 ±0.25	0.41 ±0.55	nd	0.87±0.08	MS, RI
1314.81	Phenol, 3-methyl-6-propyl	nd	0.17 ±0.23	nd	0.20 ±0.27	0.13 ±0.16	0.15 ±0.20	nd	nd	MS, RI
1332.54	Phenol, 2,6-dimethoxy	9.18±0.34	4.17 ±5.25	8.61 ±0.39	8.93 ±0.22	6.89 ±0.50	9.34 ±0.73	7.98 ±0.09	10.49±2.55	MS, RI
1340.05	Eugenol	1.14±0.07	0.99 ±0.13	1.09 ±0.06	0.96 ±0.30	0.85 ±0.06	1.41 ±0.42	0.97 ±0.04	0.53±0.74	MS, RI

RI	VOLATILE COMPOUND	Total area (%)								
		Neck	Sirloin	Leg	Loin	Flank	Breast	Shoulder	Hindshank	Identif.
1349.69	Phenol, 2-methoxy-4-propyl	2.21±0.11	0.91 ±1.15	1.97 ±0.11	2.01 ±0.56	1.62 ±0.01	1.80 ±0.01	1.86 ±0.07	1.14±1.57	MS, RI
1415.27	trans-Isoeugenol	0.77±1.01	1.24 ±0.03	1.21 ±0.04	1.15 ±0.34	1.02 ±0.10	1.28 ±0.16	1.16 ±0.06	1.35±0.66	MS, RI
1579.50	Phenol, 2,6-dimethoxy-4-(2-propenyl)	nd	nd	nd	nd	0.10 ±0.02	0.07 ±0.08	nd	nd	MS, RI
> 2000	Phenol, 4,4'-(1-methylethylidene)bis	0.04±0.05	0.02 ±0.03	nd	nd	nd	nd	nd	nd	MS, RI
AROMATIC HYDROCARBONS		**18.93±1.67**	**15.43 ±10.71**	**10.77 ±3.60**	**20.17 ±4.10**	**18.67 ±3.71**	**20.83 ±0.03**	**17.09 ±2.31**	**17.89±0.65**	
885.12	Styrene	0.04±0.05	0.05 ±0.66	nd	0.01 ±0.01	nd	0.03 ±0.04	nd	nd	MS, RI
923.90	Oxime, metoxy phenyl	5.18±3.39	5.48 ±7.51	2.98 ±3.10	6.54 ±6.54	5.84 ±1.21	6.10 ±0.36	3.56 ±0.67	2.51±0.28	MS, RI
1006.8	Benzene, 1-methoxy-4-methyl	0.05±0.07	nd	nd	nd	nd	nd	nd	nd	MS, RI
1135.75	Benzene, 1,2-dimethoxy	nd	2.12 ±2.67	nd	0.22 ±0.28	0.54 ±0.06	nd	0.21 ±0.29	0.58±0.03	MS, RI
1166.72	Naphthalene	5.07±0.23	4.59 ±0.35	4.40 ±0.31	4.14 ±0.42	3.90 ±0.12	4.11 ±0.01	4.48 ±0.48	4.74±0.06	MS, RI
1220.50	Quinoline	0.30±0.01	0.15 ±0.20	nd	0.15 ±0.21	0.21 ±0.09	nd	0.13 ±0.18	0.27±0.01	MS, RI
1235.77	Naphthalene, 1,2-dihydro-3-methyl	nd	0.13 ±0.18	nd	nd	nd	nd	nd	0.11±0.16	MS, RI
1250.79	3,5-Dimethoxytoluene	nd	nd	0.24 ±0.33	0.29 ±0.37	0.20 ±0.26	0.56 ±0.02	0.55 ±0.02	0.57±0.19	MS, RI
1322.40	1,2,4-Trimethoxybenzene	0.42±0.58	0.32 ±0.40	nd	0.67 ±0.19	0.51 ±0.12	0.81 ±0.13	0.56 ±0.15	0.88±1.09	MS, RI
1275.17	Naphthalene, 2-methyl	1.97±0.08	nd	nd	1.44 ±0.35	1.37 ±0.13	1.69 ±0.06	1.55 ±0.22	0.79±0.08	MS, RI
1291.82	Naphthalene, 1-methyl	1.29±0.06	0.75 ±0.94	0.83 ±0.08	0.54 ±0.75	0.85 ±0.06	1.06 ±0.03	0.51 ±0.70	1.05±0.03	MS, RI
1359.61	Biphenyl	1.10±0.05	0.45 ±0.63	0.87 ±0.01	0.93 ±0.17	0.74 ±0.03	0.78 ±0.25	0.89 ±0.03	0.98±0.01	MS, RI
1376.66	Naphthalene, 2-ethyl	nd	nd	nd	nd	0.28 ±0.02	0.25 ±0.12	0.29 ±0.01	nd	MS, RI
1399.82	Naphthalene, 1,5-dimethyl	0.81±0.01	nd	nd	nd	0.24 ±0.32	nd	0.58 ±0.06	nd	MS, RI
1400.61	Naphthalene, 2,3-dimethyl	1.00±0.22	nd	0.29 ±0.40	0.65 ±0.21	0.40 ±0.16	0.53 ±0.23	0.63 ±0.06	0.74±0.01	MS, RI
1404.29	Naphthalene, 2,6-dimethyl	0.57±0.79	0.68 ±0.00	nd	0.36 ±0.49	0.40 ±0.19	0.52 ±0.68	0.09 ±0.13	0.64±0,00	MS, RI
1407.55	Naphthalene, 1,7-dimethyl	nd	0.35 ±0.44	0.27 ±0.35	nd	0.26 ±0.34	nd	0.09 ±0.13	nd	MS, RI

RI	VOLATILE COMPOUND	Total area (%)								
		Neck	Sirloin	Leg	Loin	Flank	Breast	Shoulder	Hindshank	Identif.
1415.67	Naphthalene, 1,3-dimethyl	0.17±0.22	nd	0.33 ±0.43	nd	0.22 ±0.06	0.33 ±0.03	0.15 ±0.19	0.19±0.26	MS, RI
1416.88	3,5-Dimethoxy-4-hydroxytoluene	nd	nd	0.33 ±0.43	3.55 ±0.36	2.15 ±0.15	3.65 ±0.77	2.60 ±0.13	3.44±0.77	MS, RI
1435.74	Benzo[b]thiophene, 3,5-dimethyl	0.10±0.13	nd	nd	nd	nd	nd	nd	0.09±0.01	MS, RI
1444.32	Benzene, (cyclohexylmethyl)	0.11±0.14	nd	nd	nd	nd	nd	nd	nd	MS, RI
1539.13	Naphthalene, 2,3,6-trimethyl	0.18±0.25	0.21 ±0.19	nd	0.25 ±0.27	0.26 ±0.01	0.03 ±0.04	nd	0.04±0.06	MS, RI
1540.31	Naphthalene, 1,6,7-trimethyl	0.29±0.28	nd	nd	0.19 ±0.13	0.14 ±0.18	0.16 ±0.21	0.03 ±0.05	nd	MS, RI
1558.04	Fluorene	0.28±0.07	0.15 ±0.19	0.24 ±0.02	0.24 ±0.07	0.16 ±0.01	0.21 ±0.00	0.19 ±0.00	0.27±0.00	MS, RI
ACIDS		**1.00±0.64**	**0.48 ±0.42**	**0.25 ±0.10**	**9.97 ±11.83**	**1.44 ±0.68**	**4.50 ±5.68**	**9.95 ±11.99**	**0.81±0.28**	
988.86	Hexanoic acid	nd	0.28 ±0.35	nd	0.08 ±0.11	0.43 ±0.03	nd	nd	nd	MS, RI
1730.18	Tetradecanoic acid	0.18±0.00	nd	nd	0.60 ±0.62	0.10 ±0.01	0.04 ±0.03	0.35 ±0.51	0.11±0.08	MS, RI
1931.89	n-Hexadecanoic acid	0.42±0.34	0.12 ±0.02	0.14 ±0.03	5.91 ±7.2	0.37 ±0.22	0.03 ±0.04	2.63 ±2.83	0.29±0.12	MS, RI
> 2000	Oleic Acid	nd	nd	nd	nd	nd	nd	4.35 ±5.87	0.01±0.01	MS, RI
> 2000	cis-Vaccenic acid	nd	nd	nd	nd	nd	nd	0.22 ±0.31	0.01±0.01	MS, RI
> 2000	Octadecanoic acid	0.40±0.31	0.08 ±0.04	0.10 ±0.06	3.38 ±4.12	0.54 ±0.50	4.43 ±5.75	2.40 ±3.25	0.35±0.04	MS, RI
> 2000	6-Octadecenoic acid	nd	nd	nd	nd	nd	nd	nd	0.04±0.01	MS, RI
FURANS		**0.00±0.00**	**0.67 ±0.01**	**0.00 ±0.00**	**0.53 ±0.34**	**0.40 ±0.04**	**0.64 ±0.01**	**0.20 ±0.27**	**0.46±0.00**	
978.38	2(5H)-Furanone, 3-methyl	nd	0.08 ±0.01	nd	nd	0.08 ±0.01	nd	nd	nd	MS, RI
1491.37	Dibenzofuran	nd	0.59 ±0.01	nd	0.53 ±0.34	0.33 ±0.04	0.64 ±0.01	0.20 ±0.27	0.46±0.00	MS, RI
TERPENES		**0.27±0.37**	**0.13 ±0.16**	**0.07 ±0.09**	**0.24 ±0.22**	**0.24 ±0.14**	**0.20 ±0.14**	**0.22 ±0.08**	**0.19±0.02**	
1015.64	Limonene	0.27±0.37	nd	0.07 ±0.09	0.24 ±0.22	0.24 ±0.14	0.20 ±0.14	0.22 ±0.08	0.19±0.02	MS, RI
1511.01	delta,-Cadinene	nd	0.13 ±0.16	nd	nd	nd	nd	nd	nd	MS, RI

*RI-Retention index; nd-not detected

CONCLUSIONS

In all, 97 volatile aroma compounds of Herzegovinian dry smoked goat meat were found by gas chromatographic-mass spectrometry (GC-MS). Volatile compounds belonged to several classes of chemicals: aldehydes (8), alcohols (5), ketones (9), esters and lactones (8), hydrocarbons (2), phenols (30), aromatic hydrocarbons (24), acids (7), furans (2) and terpenes (2). The most common group of volatile compounds were phenols (75.12%) derived from smoke. Of all the identified volatile compounds in the examined samples, the most abundant was p-cresol, which was determined in the range from 6.60% (hindshank) to 13.25% (leg). After phenol, the most represented groups were aromatic hydrocarbons and aldehydes. In the comparison of samples according to the anatomical region, the largest number of identified compounds was found in the flank sample (64). The leg sample had the highest content of phenols and hydrocarbons, as well as the lowest content of aldehydes, acids and aromatic hydrocarbons compared to the other tested samples. Also, the specified sample had the lowest number of identified compounds compared to other anatomical parts (45). The alcohol, furan, ester and lactone content was characteristic of the sirloin sample. The neck sample had the highest content of aldehydes and terpenes, the loin sample of ketones and acids, while the breast sample had the highest content of aromatic hydrocarbons. The results of research of volatile aroma compounds indicate that the aroma profile of Herzegovinian dry smoked goat meat is specific. The aroma of this product is the result of the specific characteristics of the meat, climatic factors, the plant material that the animals are fed with and the production technology. Future research should include the analysis of the flora of pastures and meadows to identify potential biomarkers of Herzegovinian dry smoked goat meat.

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