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The effect of pale, soft and exudative meat on the quality of canned pork in gravy

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A B S T R A C T

The objective of the study was to evaluate the use of PSE meat in the production of sterilized pork type canned meat in its own gravy. Canned meat products were produced with 50% of PSE meat as well as with 100% PSE meat, and compared with canned meat products of good quality (RFN). It was found that decreased quality of PSE meat had a small impact on the quality of canned meat products. Substitution of both 50% as well as the total quantity of RFN meat with PSE meat did not affect the course of the sterilization process, neither increase the quantity of excreted fat and jelly in canned meat. It also had no effect on the instrumentally-measured parameters of texture and neither did it affect different sensory quality features, including the overall desirability of the product. The PSE canned meat product were characterized by higher values of L^* and b^* color parameters.

1. Introduction

The issue of the occurrence of PSE pork meat has been of interest to researchers for many years (Adzitey & Nurul, 2011; Barbut et al., 2008; Joo, Kauffman, Kim, & Park, 1999; Kauffman, Cassens, Scherer, & Meeker, 1992; O'Neil, Lynch, Troy, Buckley, & Kerry, 2003b; Rosenvold & Andersen, 2003; Warriss, Brown, & Paściak, 2006; Van de Perre, Permentier, De Bie, Verbeke, & Geers, 2010). Today, the mechanism of the occurrence of this defect in meat is well understood (Barbut et al., 2008; Bowker, Grant, Forrest, & Gerrard, 2000). There are also known genetic and environmental factors promoting its occurrence, among which the most important relate to pigs carrying the $RYR1^T$ gene (Cherel et al., 2010; Guàrdia et al., 2009) and the lack of maintenance of good animal welfare during pre-slaughter handling of animals, especially directly prior to slaughter (Gajana, Nkukwana, Marume, & Muchenje, 2013; Van de Perre et al., 2010).

Despite the clear understanding of PSE meat, the relatively high frequency of its occurrence is still a significant problem in many countries. It is estimated that the incidence of this quality defect, with different degrees of intensity, remains between a few percentage points (Faucitano et al., 2010; Scanga et al., 2003) and even >30% (Santos, Roseiro, Goncalves, & Melo, 1994; Schilling et al., 2004). Because the formation of the PSE defect is influenced by many different factors (Pisula & Florowski, 2006; Rosenvold & Andersen, 2003), it can be assumed that, at present, it is practically impossible to completely eliminate its occurrence under the large-scale production conditions. The meat industry will thus be exposed to losses associated with the occurrence of such raw material (Kuo & Chu, 2003; Schilling, Mink, Gochenour, Marriott, & Alvarado, 2003).

The processing yield of PSE meat requires additional actions aimed at reducing its adverse impact on the quality of the finished product. Most commonly, these actions include the use of functional additives, such as phosphates (Kobyliński & Florowski, 2012; Torley, D'Arcy, & Trout, 2000), soy proteins (Florowski, Florowska, Kur, & Pisula, 2013; Motzer, Carpenter, Reynolds, & Lyon, 1998), collagen proteins (Florowski et al., 2013; Schilling et al., 2003), and hydrocolloids (Schilling et al., 2004), or the use of transglutaminase enzymes (Katayama, Chin, Yoshihara, & Muguruma, 2006). Attempts have also been made to use extracts from mechanically deboned turkey meat (MDTM) (Li & Wick, 2001). To reduce the adverse impact of PSE on meat product quality, attempts have also been made to mix it in the production process with meat of good quality, most commonly in the proportions 25%–50% for PSE and 50%–75% for RFN meat (Kuo & Chu, 2003; Motzer et al., 1998; Schilling et al., 2003; Schilling et al., 2004). There have also been attempts to modify the production technology of products containing PSE meat, for example using restructuring technology (Florowski, Florowska, Adamczak, Kur, & Pisula, 2014; Motzer et al., 1998; Schilling, Marriott, & Acton, 2001). The above methods, although allowing the production of a finished product of acceptable quality from PSE meat, are associated with additional costs related to the use of functional additives, or require modification of production technology. Moreover, they often lead to the production of products with decreased market value in comparison to those products which are produced from good quality meat.

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Production of sterilized pork-type meat in its own gravy seems to be an interesting alternative to utilizing PSE meat, which has not been previously described in the scientific literature. The purpose of making an attempt to utilize PSE meat in the production of such types of products results from their characteristics. In the production of pork-type canned meat in its own gravy, the meat is grinded and then mixed, which could lead to the unification of the quality of meat batter; thereby, minimizing the risk of the development of point quality defects of the product. An additional advantage is that after opening canned meat of this type, the presence of jelly on the surface of the block of meat is required (thermal drip in the form of jelly). In this case, reduced water-holding capacity characteristics for PSE meat and an increased quantity of thermal drip may not necessarily constitute an adverse feature translating into product quality.

The objective of the study was to determine the possibility of utilizing PSE meat in the production of sterilized pork-type canned meat in its own gravy. In the studies, we produced both canned meat with a 50% proportion of PSE meat as well as PSE meat exclusively. The effect of PSE meat on the sterilization parameters of canned meat products and their quality characteristics were determined.

2. Materials and methods

2.1. Samples

Material used for the study consisted of pork meat (*m. semimembranosus*) with PSE defect and normal-quality meat (RFN). The material was derived from the industrial slaughter of pigs. The animals were diverse in terms of the genotype and environmental conditions of breeding. Pigs were subjected to electrical stunning and bled in a hanging position. Cooling of the carcasses was performed via the two-stage method (I stage: temperature of about −10 °C for 1–2 h; II stage: temperature of 0–4 °C for about 22 h). Meat cutting and its quality classification were done about 24 h after pigs' slaughter, directly on the cutting lines of a meat processing plant. Classification of PSE and RFN material was based on the results of visual assessment and the results of the measurement of electrical conductivity (EC). EC classification method is very useful for detecting PSE meat (Garrido, Pedauyé, Bañon, López, & Laencina, 1995). To measure electrical conductivity (EC), Meat Quality Tester type MT-03 (Department of Microprocessor Technology EXE, Poznan, Poland) was used. The measurement was performed by thrusting an electrode into meat across the muscle fibers. In the classification, an accepted value of criterion was established at the level of 10 mS (>10 mS = PSE meat; <10 mS = RFN meat) recommended by the device manufacturer. The average value of the electrical conductivity of PSE meat was established at 12.1 mS and 8.1 mS for PSE and RFN meat, respectively. To ensure that collected meat is of good quality or that it is PSE after the EC classification additional visual classification was conducted. Visual classification was conducted after removal of fat deposits from the surface of the meat samples and after mechanical removal of the membrane. From the group of samples classified based on the measurements of electrical conductivity as PSE, for further studies only those samples were selected that were characterized by very light color, an unusual, too “loose” and delaminating structure and excessive wateriness of the surface. Among the group of samples classified based on the measurement of electrical conductivity as RFN, for further studies only those samples with a normal, pink-red color, concise structure and surface, without signs of excessive wateriness were selected. A total number of 12 samples of RFN meat and 12 samples of PSE meat with an average weight of 1100 g per sample were selected. The selected meat samples were vacuum packed in polyethylene bags, frozen and stored in a cold store at a temperature of −22 °C for about two weeks. On the day prior to production of canned meat, meat samples were thawed in a cooling room at a temperature of 4–6 °C for about 24 h. From the thawed meat, after removal of the thawing loss, sterilized pork-type canned meat products in their own gravy were produced.

2.2. Production of sterilized pork-type canned meat in its own gravy

The processing technology and the formula for pork-type canned meat in its own gravy were taken from industrial practice, adjusting to experimental conditions on a semi-technical scale. Four independent production series were carried out. The formula for canned meat products is shown in Table 1. The meat was cut to form cubes with sides of approximately 2 cm. Ten percent of the meat provided with the recipe (depending on the variant of canned meat product, this was RFN, PSE or RFN and PSE meat) was scalded in water at 90 °C for 5 min and then ground in a laboratory grinder (MESKO AL. 2–4, MESKO-AGD Sp. z o.o., Skarżysko-Kamienna, Poland) equipped with a grid with holes of 4.5 mm diameter. Fresh onion was shredded by hand and fried for 15 min (until golden color). After frying, the onion was placed on a sieve to separate the fat, and then minced in laboratory grinder equipped with a grid with holes of 4.5 mm diameter. Pork rinds derived from porkshank were scalded for 10 min in water at a temperature of 90 °C. Then, the rinds were filtered and ground in a laboratory equipped with a grid with holes of 4.5 mm diameter. In the production, flavored spices (pepper, marjoram) from the manufacturer Kamis (Wólka Kosowska, Poland) were used.

Meat batters were prepared in a mixer (Kenwood Major typ KM 800, Kenwood Ltd., Havant, England), mixing for 2 min until a uniform distribution of the ingredients was obtained. Then, steel cans with a diameter of 76 mm and a height of 54 mm were filled with the batters by introducing 200 g of stuffing into each package. For each product variant in each test series, 5 cans were prepared. After filling the packages, they were left for 1 h at 18–20 °C to align the initial temperature of the batters prior to the sterilization process, and then sealed using a semi-automatic closing machine (Nov-Handy Novopacké, Wahlstedt, Germany). In each test series, in two cans, i.e. one filled with batter made from PSE meat and the other one made from RFN meat, a hole was made in the middle of its height and a special feedthrough was placed inside, enabling installation of sensors (TrackSense® PRO Logger, Ellab, Hilleroed, Denmark) to control the parameters of the sterilization process. The sensors recorded the temperature inside the autoclave and in the geometric center of the can every 30 s, with an accuracy of 0.1 °C. The length of the probe of the sensors was adjusted to the diameter of the cans (76 mm) and enabled the location of probe tips in the geometric center of the package. Cans with batter were randomly placed inside the water-steam autoclave (A-125E, Jugema, Środa Wielkopolska, Poland) initially preheated to 90 °C. The heating time of the autoclave to sterilization temperature (121.1 °C) was established at approximately 10 min. The proper sterilization was performed for 45 min, allowing their required commercial sterilization value of $F_0 \geq 3$ of cans to be obtained. After the sterilization process, cans were cooled for 15 min until the temperature inside reached 85–90 °C, maintaining an overpressure of about 0.1 MPa in the autoclave. After adjusting the pressure inside the autoclave to atmospheric pressure, the system was opened and the cans were dried and placed in the stock. The sensors used to measure parameters of sterilization were removed from the cans and transferred

Table 1
Formulation of canned pork in its own gravy made of different levels of PSE meat (g).

	Type of formulation		
	100% RFN	50% RFN + 50% PSE	100% PSE
RFN meat	900	450	–
PSE meat	–	450	900
Pork rind	72	72	72
Onion	9.7	9.7	9.7
Salt	17.5	17.5	17.5
Pepper	0.97	0.97	0.97
Marjoram	0.19	0.19	0.19