LWT - Food Science and Technology 69 (2016) 319–326

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Effect of natural marinade based on lactic acid bacteria on pork meat quality parameters and biogenic amine contents

Erika Mozuriene [a], Elena Bartkiene [a], Vita Krungleviciute [a], Daiva Zadeike [b, *], Grazina Juodeikiene [b], Jonas Damasius [b], Aldona Baltusnikiene [a]

[a] Department of Food Safety and Quality, Lithuanian University of Health Sciences, Veterinary Academy, Tilzes Str. 18, LT-47181 Kaunas, Lithuania
[b] Department of Food Science and Technology, Faculty of Chemical Technology, Kaunas University of Technology, Radvilenu Str. 19, LT-50254 Kaunas, Lithuania

ARTICLE INFO

Article history:
Received 25 July 2015
Received in revised form
23 December 2015
Accepted 26 January 2016
Available online 29 January 2016

Keywords:
Pork quality
Color
Potato juice
Fermentation
Lactic acid bacteria
Biogenic amine

Chemical compounds studied in this article:
L-lactic acid (PubChem CID 107689)
D-lactic acid (PubChem CID 61503)
Phenylethylamine (PubChem CID 1001)
Putrescine (PubChem CID 1045)
Cadaverine (PubChem CID 5351467)
Histamine (PubChem CID 5818)
Tyramine (PubChem CID 66449)
Spermidine (PubChem CID 39519)
Spermine (PubChem CID 1103)
Tryptamine (PubChem CID 67652)

ABSTRACT

The objective of this study was to evaluate the physicochemical (i.e. pH value, color, cooking loss, water holding capacity (WHC), tenderness) and sensory quality, and biogenic amine (BAs) contents of pork meat after treatment with natural marinade based on lacto-fermented potato tuber juice. The *P. acidilactici* KTU05-7, *P. pentosaceus* KTU05-9 and *Lactobacillus sakei* KTU05-6 were used as starter cultures for potato juice fermentation. The present study demonstrates the significant differences ($P < 0.05$) between the quality characteristics of the marinated and unmarinated samples. Pork meat marination (24 h) with lacto-fermented marinade lowered the WHC thus increased cooking loss as compared to the controls. Marination reduced the lightness and the yellowness and increased the redness of pork meat. The sensory analysis showed that marinated meat in all cases had significantly higher ($P < 0.05$) acceptability scores depended on the LAB strain used for marinade preparation. The phenylethylamine (7.14–35.49 mg/kg), putrescine (14.56–131.29 mg/kg) and cadaverine (13.15–49.91 mg/kg) were predominant BAs in all pork meat samples; however BAs concentrations were far below the levels causing a health risk. The study shown that *P. pentosaceus* KTU05-9 and *P. acidilactici* KTU05-7 are most suitable for potato juice fermentation, and such products could be recommended for the pork meat marination to improve its color and tenderness and to increase the acceptability.

1. Introduction

Marination is a common technique used to improve meat quality attributes, such as water-holding capacity, tenderness and

* Corresponding author.
E-mail addresses: erika.mozuriene@lsmuni.lt (E. Mozuriene), elena.bartkiene@lsmuni.lt (E. Bartkiene), vitakrungleviciute@gmail.com (V. Krungleviciute), daiva.zadeike@ktu.lt (D. Zadeike), grazina.juodeikiene@ktu.lt (G. Juodeikiene), jonas.damasius@ktu.lt (J. Damasius), aldonabalt@lva.lt (A. Baltusnikiene).

http://dx.doi.org/10.1016/j.lwt.2016.01.061
0023-6438/

flavor of the meat. Trends in meat industry are focalizing in products with high organoleptic standards, textures, long shelf-life and containing specific nutrients to cover special consumer requirements (Fadda, López, & Vignolo, 2010). Citric acid, a food acidulant is often used in meat marination to improve the water holding capacity (WHC) and tenderness of meat muscle (Ke, Huang, Decker, & Hultin, 2009). Also, the use of LAB as biological preservatives on meat products could confer health benefits to consumers. The preservative ability of lactic acid bacteria (LAB) in foods is attributed to the production of anti-microbial metabolites including organic acids and bacteriocins (Fadda et al., 2010). Its fermentative metabolism prevents the development of spoilage and pathogenic microflora by acidification of the product, also contributing to its color stabilization and texture improvement (Olaoye & Idowu, 2010). *Lactobacillus sakei*, *Lactobacillus curvatus*, *Staphylococcus carnosus*, *Staphylococcus xylosus* and *Staphylococcus saprophyticus* are often used as starter cultures in industrial meat fermentation (Tsuda, Teruki, & Yoshiko, 2012).

In the case of large-scale production, it is necessary to search for a specific low-cost culture medium for LAB cultivation. The ability of LAB to utilize potato juice of various cultivars in cell synthesis and lactic acid production without external nutrient supplement was reported by Kim, Jang and Yoon (2012). Due to their low cost, low fat content, and good source of carbohydrate, good nutritional quality protein with a relatively high lysine content, fiber, and vitamins, potatoes play an important role in human nutrition (Kim et al., 2012).

Furthermore, biogenic amines (BAs) can occur in fermented meat products at high concentrations since their accumulation is mainly related to the action of decarboxylase-positive bacteria and meat enzymes during fermentation and ripening (De Mey et al., 2014). The biogenic amine determination is important not only because of their toxicity but also their potential use as freshness indicators (Balamatsia, Paleologos, Kontomina, & Savvaidis, 2007).

However, LAB strains produce lactic acid which occurs naturally in two optical isomers, D(−) and L(+)-lactic acids (Vijayakumar, Aravindan, & Viruthagiri, 2008). In particular, the food and pharmaceutical industries have a preference for the isomer L(+), the only one that can be metabolized by the human body (Wee, Kim, & Ryu, 2006). The D(−) form of the lactic acid is toxic for a human (Kang, Lee, & Kang, 2006). D-lactic acidosis is a rare metabolic complication in humans, but is occasionally observed as a consequence of short-bowel syndrome (Uchida et al., 2004). D-lactic acid accumulation in the blood can cause neurologic symptoms such as delirium, ataxia, and slurred speech (Kang et al., 2006). Thus, research is needed in regard to the D-lactate in with LAB marinade treated meat products.

The objective of this study was to evaluate the physicochemical and sensory quality, and biogenic amine (BAs) contents of pork meat after treatment with natural marinade based on potato tuber juice fermented by the probiotic lactic acid bacteria *P. acidilactici* KTU05-7, *P. pentosaceus* KTU05-9 and *L. sakei* KTU05-6.

2. Materials and methods

2.1. Materials

The lactic acid bacteria *P. acidilactici* KTU05-7, *P. pentosaceus* KTU05-9 and *L. sakei* KTU05-6, previously isolated from spontaneous rye sourdoughs (Digaitiene, Hansen, Juodeikiene, Eidukonyte, & Josephsen, 2012), were from the collection of the Kaunas University of Technology (Lithuania). Fresh pork meat parts (neck, shoulder, muscle ham, *M. longissimus dorsi* and loin) were obtained from a local market (Kaunas, Lithuania) and stored at 4 °C in a refrigerator. Potato (var. Vinetta) tubers were obtained from a local farm (Mazeikiai, Lithuania) in 2014. The tubers were stored at 15 ± 1 °C (relative humidity 70–75%) in the dark until further analysis.

2.2. Methods

2.2.1. Potato juice fermentation

Fresh potato tubers after washing with tap water were crushed, filtered, and the obtained potato juice was centrifuged to remove the excess of starch. Juice (250 mL) after sterilization at 121 °C for 20 min was cooled to 30 °C, mixed with 5 mL of pure LAB cell suspension containing on average 8.9 log cell forming units (cfu)/mL, and incubated at a temperature optimal for an individual LAB strain (35 °C for *P. acidilactici* and *P. pentosaceus* and 30 °C for *L. sakei*) for 72 h. The final LAB cell number was calculated after 24, 48 and 72 h of fermentation.

2.2.2. Microbiological analysis

For microbiological analysis, the marinade sample (10 mL) was homogenized with 90 mL of sterilized saline (0.9% NaCl). Serial dilutions (10^{-4}–10^{-8}) with saline were made. The obtained suspensions were spread on the MRS agar (CM0359, Oxoid Ltd, Hampshire, UK) and incubated under anaerobic conditions at 30 °C for 72 h. The LAB cell concentration was expressed as a log cfu per mL.

2.2.3. Meat marination process

Each pork meat sample was divided into sub-samples (each 100 g). The experimental design consisted of two group, one group of meat sub-sample used as a control (no marination) n = 3. The other group was weight and individually identified (n = 3) and were immersed in the marinade. The proportion between the meat and the marinade was fixed at 1: 2. The samples were then enclosed in the sealed plastic pouches and stored in a refrigerator for 24 h. After marination, meat samples were collected for the texture, color, acidity, biogenic amines analysis.

2.2.4. Analyses

For acidity determination, a meat sample (5 g) was homogenized with 50 mL of distilled water and filtered. The pH was determined directly using a portable pH meter with a puncture electrode (Delta Track Inc., Pleasanton, CA). The total titratable acidity (TTA) was expressed as the milliliters of 1 M NaOH used to neutralize organic acids in 100 g of a sample. The moisture content was determined according to the AOAC 950.46 method (AOAC, 2006). Each sample (5 g) was oven-dried (UNB400, Memmert, Germany) at a temperature of 105 °C to a constant weight and expressed as a percentage of the initial sample weight. The drip loss of meat was measured as a fluid loss from marinated meat via passive exudation (5 °C; 24 h) and expressed as a percentage of the initial weight of the product (Fischer, 2007). Water holding capacity (WHC) was determined by the filter paper method according to Grau and Hamm (1956) and expressed as the percentage of loose water in meat. A meat sample was compressed between two layers of filter paper and two plaques of acyclic Plexiglas at a force of 5 N for 60 s using the compression technique (Lloyd Instruments Ltd., Hampshire, UK). The cooking loss was determined after cooking a 100 g sample in a 100 °C temperature water for 15 min and expressed as a percentage of the initial weight. The tenderness of pork samples was measured as a shear force (kg/cm^2). After cooking, the pork samples were cooled to room temperature, sliced using a knife into slices 40 mm long and 10 mm thick, parallel to the muscle fibers, and analyzed for tenderness using a texture analyzer (TA-XT2i; Texture Technologies, Scarsdale, NY, USA) with a 5-kg load cell using a razor blade (height 24 mm; width 8 mm) set to