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Spent brewer's yeast extract as an ingredient in cooked hams

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ABSTRACT

This work describes the effect of the incorporation of 1% spent yeast extract into cooked hams. Physical/chemical/sensorial characteristics and changes during 12 and 90 days storage were evaluated on control and treated cooked hams processed for 1.5, 2.0, 2.5 or 3 h. Spent yeast extract addition increased hardness, chewiness, ash, protein and free amino acid content. Similar volatile profiles were obtained, although there were some quantitative differences. No advantages were observed for increased cooking time.

No significant differences were observed for physical and sensorial parameters of cooked hams with spent yeast extract at 12 and 90 days post production, but His, aldehydes and esters increased at the end of storage. This behaviour was similar to that observed for control hams.

The higher hardness of cooked ham with 1% yeast extract was due to the stronger gel formed during cooking and was maintained during storage. This additive acts as gel stabilizer for cooked ham production and could potentially improve other processing characteristics.

1. Introduction

In the brewing industry yeast is reused several times for beer fermentation and then discard when the cell viability decreases and autolysis rises (Vieira et al., 2012). Spent yeast is the second major by-product from the brewing industry (Ferreira, Pinho, Vieira, & Tavarela, 2010). Brewer's yeast is generally recognized as safe (GRAS) and has good nutritional characteristics, because it is rich in amino acids, peptides, nucleotides and other soluble components (Chae, Joo, & In, 2001; Vieira, Brandao, & Ferreira, 2013), but its use is still limited, being basically used as animal feed due to its high protein content (Ferreira et al., 2010). Nowadays, yeast extracts are receiving increased attention as flavour enhancers in low-sodium fermented sausages and cured meat products and also in sauces, gravies, soups, chips and crackers (Campagnol, dos Santos, Wagner, Terra, & Pollonio, 2011).

Cooked ham is a widely consumed meat product with a typical pink colour and characteristic flavour. It consists mainly of meat cuts from pig leg and its production process includes the addition of additives and ingredients to the brine, which is applied by injection into the meat pieces (Xargayó, 2010). The brine promotes the binding of muscles and protein solubilisation. Additionally, the cooked ham process includes tumbling and/or massaging to distribute the brine. This process accelerates the extraction of myofibrillar proteins that cause binding of meat pieces and colour development (Krause, Plimpton, Ockerman, & Cahill, 1978). Finally, cooking and cooling steps are applied for microbial destruction, enzyme inactivation and development of sensory properties. Variable cooking times can be used by the industry, since it influences physical/chemical characteristics, texture and flavour. Longer cooking time(s) may be used to improve binding strength, however, it can also be detrimental to flavour and product yield commercially (Toldrá, Mora, & Flores, 2010) and increase energy costs. After rapid cooling the hams are stored at 4 °C during 12 days, for maturation.

The addition of non-meat proteins is a common practice to reduce production costs, improve texture, or increase yield in the meat industry (Dutra et al., 2012). The use of high-protein non-meat additives, such as skim milk powder, sodium caseinate and whey has been studied (Ellekjær, Næs, & Baardseth, 1996; Yetim, Müller, Dogan, & Klettner, 2006). These authors concluded that the addition of these ingredients was economically advantageous because it decreased cooking losses, improved stability, and improved the textural characteristics of cooked meats, such as binding strength and firmness. Previous research employed whey protein concentrates, isolates or fluid whey, but no

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studies are described concerning the use of protein rich extracts from spent yeast biomass from the brewing industry to produce cooked ham. However, spent yeast has potential to increase ham quality due to its high protein content (Caballero-Córdoba & Sgarbieri, 2000) that can improve texture. Additionally, it contains nucleotides that can act as flavour enhancers and increase ham sensorial characteristics (Vieira et al., 2013). It is also a good source of minerals and vitamins that will improve ham nutritional composition. The goal of this study was to evaluate the impact on cooked ham characteristics by adding brewing spent yeast extract as an ingredient. Preliminary trials indicated that 3 and 5% brewer's yeast extract had a detrimental effect on ham organoleptic characteristics. Thus, we hypothesize that inclusion of 1% spent brewer's yeast extract will enhance the physical, chemical, textural and sensorial characteristics of hams cooked for various time periods. These parameters were evaluated after 12 days, and for some attributes 90 days post production.

2. Materials and methods

2.1. Spent yeast extract

Brewing spent yeast biomass was supplied by a local beer industry. The brewing spent yeast biomass was washed at least three times with deionized water at a ratio of 1:3 (w/v) (yeast biomass:water) and between each wash it was centrifuged at 10,000 ×*g*, 4 °C, 5 min. The cell wall was destroyed with glass beads at a ratio of 1:2:1 (biomass:0.04 M acetate buffer pH 5:glass beads, g/v/g) by vortexing 10 times (1 min each). The homogenate was centrifuged at 15,000 ×*g*, 4 °C for 30 min. The resulting pellet was discarded and the supernatant was used as a cell wall-free extract. For each batch of yeast added to cooked ham, 1000 ml of extract were prepared, lyophilized and resuspended with 0.04 M acetate buffer to achieve a final volume of 250 ml of spent yeast extract. Total protein in *Saccharomyces* spent extract was measured by Bradford micro assay method at 595 nm (Bradford, 1976). Free amino acids (FAA) of spent yeast extract were analysed according to Pérez-Palacios, Melo, Cunha, and Ferreira (2013). Norleucine (5 μg ml^{-1}) was used as an internal standard and derivatization with N-Methyl-N-tert-butyldimethylsilyltrifluoroacetamide (MTBSTFA) was performed. The chromatographic analyses were carried out in an Agilent 6890 gas chromatograph (Agilent, Avondale, PA, USA) coupled to a MS detector (Agilent 5973). Free AA quantification in the extracts was carried out in the SIM mode by external calibration curve method. For each AA, a calibration curve (quantification ion AA peak area/quantification ion IS peak area versus AA amount) was constructed. The content of each amino acid in spent yeast extract was expressed in μg/l.

2.2. Cooked ham sampling

Control cooked ham samples were prepared by the industry at pilot scale. Control cooked hams required 40 kg of pork leg cuts injected with 35% brine containing sodium chloride, dextrose, polyphosphates, sodium nitrite, sodium erythorbate, maltodextrin, sodium citrate, glutamate, carrageenan, fibre, and aromas. Meat was tumbled 9 h at 0–4 °C with vacuum (Technical, PULMAX 200) with 7 cycles/min, finally 24 hams were packaged. Cooking was performed in an oven (Verinox, Junior 1100) with a constant atmosphere temperature of 80 °C to obtain a core temperature of 68 °C. Four different cooking times, 1.5, 2, 2.5 and 3 h were tested and six hams were collected for each cooking time. After the cooking stage, samples were cooled with ice and refrigerated at 0–4 °C overnight and stored 12 days for maturation as usually done by the industry. Three hams from each cooking time of control hams were collected to perform laboratorial and sensorial analysis ($n = 12$) and another 3 samples of each cooking time were collected ($n = 12$) after 90 days to repeat laboratorial and sensorial analyses and evaluate changes that occurred during storage. Two different batches of 24 control hams were prepared as described before, thus, a total of 48 control hams were analysed in triplicate.

Cooked ham with spent yeast extract was prepared using a similar protocol except that 1% of yeast extract was mixed with the brine, injected into the ham and distributed by vacuum tumbling. Two different batches of 24 hams with spent yeast extract were prepared as described before, making a total of 48 hams that were analysed in triplicate.

Routine microbiological analyses as performed in the ham industry were carried out to guarantee the safety of cooked ham samples (Total plate count per cm^2 ($<10^4$) and Enterobacteriaceae per $cm^2 < 100$).

2.3. Proximate composition of cooked ham samples

Proximate composition, moisture, ash, total protein and fat content were evaluated using AOAC (2000) (No. 950.46, No. 920.153, No. 928.08 and No. 991.36, respectively). pH measurements were performed with a combined pH glass electrode connected to a pH-meter (MicropH 2001, Crison, Barcelona, Spain).

2.4. Physical analyses of cooked ham

Colour analysis was performed using a Minolta colorimeter (Model No. CR-400, Konica Minolta Sensing Americas Inc., Ramsey, NJ, USA) calibrated to an internal light (D65) before the measurement of L* (lightness), a* (redness/greenness) and b* (yellowness/blueness) attributes. Hams were cut in half and measurements were carried out at three randomly chosen points.

TPA analysis was performed according with González, Suárez, and Martínez (2009). Cooked ham samples were cut into cubes 20 × 30 mm using a steel cutter from a 30 mm central slice. Texture profile analysis (TPA) was performed using a TA-XT2i texture analyser (Stable Micro Systems®) equipped with a load cell of 25 kg and a probe of 20 mm diameter SMSP/20. The operating conditions were: cubes were compressed along the longitudinal axis to 7.5 mm, pre-test speed of 2 mm/s, test speed of 10 mm/s, post-test speed 5 mm/s compression time between 1 s. Two-cycle compression was applied.

2.5. Chemical composition of cooked ham

Free amino acids (FAA) of cooked ham were analysed using the same method described for analyses of spent yeast extract. The FAA content of cooked ham was expressed in μg/100 g dry weight.

Volatile compounds were extracted by headspace solid phase microextraction (HS-SPME) and analysed by Chromatographic analysis (Varian 4000 GC–MS–MS) coupled to a mass selective detector (Varian 240MS/4000 Mass Spec) (Pérez-Palacios, Petisca, Melo, and Ferreira (2012). To extract volatile compounds a PDMS-DVB SPME fibre (65 μm, Supelco Co., Bellefonte, PA, USA) was used. All automated HS-SPME experiments were performed using the Combi-PAL autosampler (Varian Pal Autosampler, Switzerland) and the Cycle Composer software (CTC Analytics System Software, Switzerland). The agitation temperature was 55 ± 1 °C and each sample was incubated 5 min at an agitation speed of 250 rpm. Fibre was exposed to the HS for 45 min under constant agitation (250 rpm). Thereafter, the SPME fibre was inserted and desorbed for 4 min at 230 °C, in the split-less mode, with 1 ml/min-flow.

2.6. Sensory analysis of cooked ham

Sensory analysis was performed by 13 trained panellists from the ham industry. The panellists were selected on the basis of the following criteria: (1) between 24 and 55 years old, (2) nonsmokers, (3) do not have food allergies (4) have a complete natural dentition, (5) are ham consumers, (6) and are available for and show an interest in sensory sessions. The parameters evaluated were texture in mouth, colour,