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Microbial transglutaminase and caseinate as cold set binders: Influence of meat species and chilling storage

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Abstract

The effect of microbial transglutaminase/sodium caseinate (MTG/C) systems on meat batter characteristics (water binding and textural properties of raw and cooked products) was studied in the presence of NaCl (1.5 g/100 g) and sodium tripolyphosphate (0.5 g/100 g), and storage time (96 h at 3 °C) for three meat species (pork, chicken, lamb). Samples prepared from pork and lamb with only MTG/C (no salts) had the highest cooking loss (CL) values, about 23 and 29 g/100 g, respectively; for chicken, the CL was less than 13 g/100 g. Hardness (Hd) and chewiness (Cw) generally tended to be higher in cooked samples containing MTG/C than in samples containing only salts. Products combining salts and MTG/C had higher ($P<0.05$) Hd and Cw. The efficiency of the MTG/C system as a texture conditioner of cooked products varied with the meat source.

Keywords: Pork; Chicken; Lamb; Meat batters; Microbial transglutaminase; Caseinate; Physicochemical characteristics

1. Introduction

Reformed and restructured meat products are traditionally prepared using salt and phosphate, which, with the aid of mechanical action, promote the extraction of myofibrillar proteins; upon cooking, these form a stable protein matrix with a beneficial effect on product characteristics (cohesion, cook yield, etc.). Such products can only be marketed either precooked or frozen because the product bind is not very strong in the raw state. However, consumers tend to appreciate these products less than fresh, unfrozen meat products (Wijngaards & Paardekooper, 1988; Kuraishi et al., 1997). Several cold-set (chemically set) binding systems have been developed to meet the demand (sensory properties and handling characteristics) for meat products that can be sold raw in the chilled state (Wijngaards & Paardekooper, 1988; Esguerra, 1994; Nielsen, Petersen, & Moller, 1995; Kuraishi et al., 1997).

Transglutaminase is an enzyme that catalyzes covalent cross-link formation in different proteins and provides an important tool for food processing. The use of transglutaminase has been described as a procedure for cold gelification of muscle protein that can reduce or eliminate the need to add salt and phosphate (Wijngaards & Paardekooper, 1988; Nielsen et al., 1995; Kuraishi et al., 1997). Some studies suggested the possibility of using the procedure to bind meat pieces below 10 °C (Wijngaards & Paardekooper, 1988); however, for practical purposes there were certain limitations. First, the enzyme was used at high temperature (37 °C) to optimize the cross-linking reaction, which for reasons of hygiene is not appropriate for fresh meat processing (Nielsen et al., 1995); and second, the process (which entails mixing of fibrinogen and thrombin prior to use for restructuring) was too complicated to be of immediate practical use (Kuraishi et al., 1997).

Given that transglutaminase with caseinate formed a viscous sol which could act as a glue to bind restructured meat pieces together, Kuraishi et al. (1997) reported that

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a microbial transglutaminase (MTG)/sodium caseinate system (0.05–0.1 MTG/0.5–1 caseinate, g/100 g) could be usefully employed as a meat binder at low temperature (5 °C). With this system, transglutaminase could serve as a real cold-set binder to produce restructured meat in the raw, refrigerated state without addition of salt. However, their study had no data on how this treatment might affect important product characteristics such as the water binding properties in the raw state, and the water binding and textural properties of the cooked muscle food.

There have been numerous studies on the use of transglutaminase in meat products; in most cases the enzyme was used at low temperature (<10 °C) and for short periods of time (Kuraishi et al., 1997; Kerry, O'Donnell, Brown, Kerry, & Buckley, 1999; Pietrasik & Li-Chan, 2002; Ruiz-Carrascal & Regenstein, 2002; Kilic, 2003; Pietrasik, 2003), or at higher temperatures, either with heating up to optimum levels for activity (40–50 °C) (Muguruma et al., 1999; Ruiz-Carrascal & Regenstein, 2002) or during cooking (70–85 °C) to bring about better product characteristics in meat emulsions (Muguruma et al., 1999), ham (Olkiewicz & Ostrowska, 2001), or meat-balls (Tseng, Liu, & Chen, 2000). Depending on the heating rate, transglutaminase can be active for some time (Motoki & Seguro, 1998). In most studies when the enzyme reaction was done at low temperature (as a cold-set binder), the enzyme was allowed to act for little more than 24 h before the product was frozen (Kuraishi et al., 1997) or heated, depending on the kind of meat product (Chen, Chou, & Liu, 1998; Pietrasik & Li-Chan, 2002; Ruiz-Carrascal & Regenstein, 2002; Kilic, 2003; Pietrasik, 2003; Pietrasik & Jarmoluk, 2003). Nevertheless, for practical application of the MTG/C system in restructured meat prepared for distribution as a chilled product, the effect of this cold-set binder needs to be assessed for longer times to reflect real commercial conditions. More needs to be known about how the time in chilled storage can affect the characteristics of raw or cooked meat systems prepared with MTG as a cold-set binder.

Transglutaminase has been used in products made from pork (Kuraishi et al., 1997; Olkiewicz & Ostrowska, 2001; Pietrasik & Li-Chan, 2002; Pietrasik & Jarmoluk, 2003), beef (Kerry et al., 1999; O'Kennedy, 2000; Pietrasik, 2003) and chicken (Kerry et al., 1999; Tseng et al., 2000; Ruiz-Carrascal & Regenstein, 2002; Kilic, 2003), but to our knowledge there have been no studies of its use in lamb products. There is some evidence that the effect of the MTG may be influenced by the meat species (Kerry et al., 1999; Muguruma et al., 1999); however, there are not many comparative studies available on the influence of this factor and its consequences for the properties of raw and cooked meat products.

In short, MTG/C systems offer major possibilities as cold-set binders for restructured meat production (Kuraishi et al., 1997), but there has been little research into their actual use, particularly as regards the influence of the meat species and the effect of these systems on meat product characteristics over several days in chilled storage, which is important for distribution of restructured meat in the chilled state. The purpose of this experiment was to obtain a better understanding of restructuring techniques that do not require freezing or heating, by studying the effect of a TGM/C system on meat batter characteristics (water binding, and mechanical properties of raw and cooked products) as a function of meat species (pork, lamb and chicken), the presence of salt and phosphate, and storage time.

2. Materials and methods

2.1. Materials

Fresh meat from chicken breasts, pork legs and lamb legs (all domestic products) were obtained from a local meat market. Meat from each species was trimmed of fat and connective tissue, and passed through a grinder with 0.6 cm orifices. Lots of approx. 1 kg were vacuum packed (Cryovac® BB4L, Sant Boi de Llobregat, Spain, oxygen permeability 30 $cm^3 m^{-2} 24 h^{-1}$ at 23 °C, 0% RH and 1 bar), frozen and stored at −20 °C until use, which took place within 3 weeks. Additives used for preparation of meat batters included sodium chloride and sodium tripolyphosphate (STP) (Panreac Quimica, S.A., Barcelona, Spain) and MTG/caseinate (ACTIVA EB, Ajinomoto Europe Sales GmbH, Hamburg, Germany) in a formulation that according to the manufacturer contains sodium caseinate 60 g/100 g, maltodextrin 39.5 g/100 g and transglutaminase 0.5 g/100 g. Transglutaminase activity (Ajinomoto's specifications) was approximately 34–65 units/g (one unit was the amount of the enzyme which catalyzed the formation of 1 μmol of hydroxamic acid/min at 37 °C). All experiments were performed with the same bacth of MTG.

2.2. Preparation of meat batters

Meat packages were thawed (approx. 18 h at 3±2 °C, reaching between −3 and −5 °C). Three different meat batters were formulated for each species (Table 1), as follows: raw meat material was homogenized and ground for 1 min in a chilled cutter (2 °C) (Stephan Universal Machine UM5, Stephan u. Sóhne GmbH & Co., Hameln, Germany). NaCl (1.5 g/100 g) and STP (0.5 g/100 g) were dissolved in the added water and chilled (2 °C); this solution (NaCl + STP + added water) was added to the meat and the whole mixed again for 1 min. Finally, MTG/C (1.5 g/100 g) was added and the