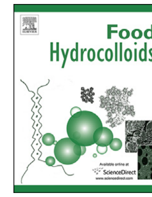
Food Hydrocolloids 83 (2018) 222–228

Contents lists available at ScienceDirect

Food Hydrocolloids

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



Effect of sodium chloride or sodium bicarbonate in the chicken batters: A physico-chemical and Raman spectroscopy study

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A R T I C L E I N F O

Article history:
Received 1 December 2016
Received in revised form
2 April 2018
Accepted 7 May 2018
Available online 9 May 2018

Keywords:
Sodium chloride
Sodium bicarbonate
Raman spectroscopy
Secondary structures
Chicken meat

A B S T R A C T

In order to research the potential of replacing sodium chloride to sodium bicarbonate, the physico-chemical and Raman spectroscopy of chicken batters with sodium chloride alone (1%) or sodium bicarbonate alone (0.5%) were studied. The pH, b^* value, cooking yield and textural properties were significantly ($p < 0.05$) increased in the batter with sodium bicarbonate. The batter with sodium chloride showed three distinct phases during the rheological measurement, but the batter containing sodium bicarbonate has two distinct phases, and has higher storage and loss modulus values at 72 °C. The frequency of admin I was a slight shift from $1659 \pm 0.58\ cm^{-1}$ to $1661 \pm 0.58\ cm^{-1}$ when added sodium bicarbonate alone, that resulted in an increase of β-sheet, β-turn and random coil content accompanied by a decrease of α-helices content. It was increased the hydrophobic interactions and ration of I_{850}/I_{830}, which caused by protein unfolding and exposure of aliphatic residues. From the above, it was concluded that sodium bicarbonate can be utilized to reduce the sodium chloride of chicken batter.

Contents

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https://doi.org/10.1016/j.foodhyd.2018.05.014
0268-005X/

1. Introduction

Emulsified meats are available in a large range of products that provide the consumer with a wide choice of textures and flavors depending on their formulas. One of sodium chloride's main functions in emulsified meats is the solubilisation of the myofibrillar proteins as it is these proteins that determine the binding and textural characteristics of the product (Perisic, Afseth, Ofstad, Hassani, & Kohler, 2013; Inguglia, Zhang, Tiwari, Kerry, & Burgess, 2017), so the tradition emulsified meats have high sodium chloride level (>2%) (Desmond, 2006). Excessive dietary sodium chloride intake can cause of cardiovascular disease and other diseases (Yalcin & Seker, 2016). Thus, reduction of sodium chloride in meat products has therefore become an important research field (Ma et al., 2012; Zhang et al., 2017).

Sodium bicarbonate has been used widely to improve the yield, tenderness and the masking of atypical aromas in meat from terrestrial farmed animals in Chinese cuisine (Asli & Mørkøre, 2012; Hsieh, Cornforth, Pearson, & Hooper, 1980). The efficacy of sodium bicarbonate is attributed to their ability to solubilize myofibrillar proteins and enhance their electrostatic repulsion (Lee, Sharma, Brown, & Mohan, 2015; Mohan, Jaico, Kerr, & Singh, 2016). Some works mainly studied that sodium bicarbonate is able to improve palatability attributes and minimize the problem of pale, soft, and exudative (PSE) meat products in chicken and pork meat (Alvarado & Sams, 2003). It could increase water holding capacity and yield, and reduced shear force presumably because of elevated pH (Bouton, Carroll, & Shorthose, 1973; Petracci et al., 2012). Sodium bicarbonate has been used in meat and fish formulations as phosphate replacer (Petraccia, Bianchib, Mudalala, & Cavani, 2013; Wachirasiri, Wanlapa, Uttapap, Puttanlek, & Rungsardthong, 2017). However, there is lack of information about the application of sodium bicarbonate in emulsified meats.

Raman spectroscopy is a non-invasive and direct technique, which can be used to provide the information of peptide backbone conformations such as secondary and tertiary structures of meat proteins (Herrero, 2008; Li-Chan, Nakai, & Hirotsuka, 1994). The tryptophan residues and tyrosine doublet bands are sensitive to the changes of protein unfolding and hydrogen bond, and they could affect the characteristics of meat batter (Herrero, 2008; Shao, Zou, Xu, Wu, & Zhou, 2011). This method has been used to study the structural changes of meat and meat systems with various amounts of sodium chloride, and found that cooked batters with 1.5% and 2.5% sodium chloride were not significantly different ($p > 0.05$) in secondary structures tryptophan and tyrosine residues (Kang et al., 2014a), but the brining beef muscle with 6% and 9% sodium chloride had a higher β-sheet structure content than the 1.5% sodium chloride (Perisic et al., 2013). However, as far as our knowledge, it has little papers reported that Raman spectroscopy was used to examine the structural changes of meat protein with sodium bicarbonate. Therefore, the objective of this research was to investigate the effects of sodium chloride alone or sodium bicarbonate alone on physico-chemical and protein conformations, evaluate the potential of replacing sodium bicarbonate as a way to reduce sodium chloride in chicken batters.

2. Materials and methods

2.1. Raw materials and ingredients

Chicken breast meat (Arbor Acres, females, 49 d old, 2.32 kg; 73.64% moisture, 22.50% protein, 2.45% fat and pH 5.90, AOAC 2000) was purchased from a local meat market (Xinxiang, China). All visible connective tissue and fat were trimmed from the meat. The meat was mixed and passed through a grinder (MM-12, Guangdong, China) fitted a plate having 6 mm diameter holes. The ground meat (500 g each) was packaged in double plastic (nylon/PE) bags and store −20 °C until use within 4 weeks. Sodium chloride and sodium bicarbonate (analytically pure) were purchased from JSC Chemical Technology CO., LTD, China.

2.2. Preparation of chicken batters

The batters were prepared with chicken meat 500 g, ice water 100 g, sodium chloride 6 g alone (S) or sodium bicarbonate 3 g alone (SB). Chicken meat were thawed (overnight at 4 °C) prior to use. The batters with sodium chloride or sodium bicarbonate were prepared in a vacuum cutter bowl (Stephan UMC-5C, Germany) with four replications at different occasions. The thawed ground meat was chopped (1500 rpm) with sodium chloride or sodium bicarbonate, and 1/3 ice for 30 s, followed by a 3 min rest; 2/3 ice were added and chopped (1500 rpm) for 30 s, followed by a 3 min rest; then finished with a high speed (3000 rpm) processing for 60 s (final temperature less than 10 °C). Then 35 g samples were stuffed into 50 mL polypropylene tubes, there were a total of sixteen tubes for each meat batter of one replication. Half of the containers with each meat batter formulation were chilled at 4 °C and analyzed as raw batters. The rest of the containers in each case were heated in a water bath at 80 °C for 20 min (the internal temperature of batters at 72 °C for 3 min). The heated samples were stored in a chiller at 4 °C until analyses.

2.3. pH measurement

The pH was determined on raw chicken batters. Approximately 10 g of each sample was homogenized with 40 mL of pre-cooled (4 °C) distilled water in a polytron at a speed of 15000 rpm for 10 s, and then pH was determined using a digital pH meter (Hanna, Italy). All measurements were performed in triplicate.

2.4. Color

The color of cooked chicken batter was measured using a Minolta chromameter (CR-40, Minolta Camera Co., Japan), calibrated with a white plate ($L^* = 96.56$, $a^* = -0.20$, $b^* = 1.82$). Five sample cores with sodium chloride or sodium bicarbonate were evaluated.

2.5. Cooking yield

The exudate separated from the cooked chicken batter was wiped away used the absorbent paper after cooling at 4 °C overnight. Then the batter was weighed and the percentage weight