EFFECT OF DIFFERENT HYDROCOLLOIDS AND CRYOPROTECTANTS ON PHYSICOCHEMICAL PROPERTIES AND SENSORY ATTRIBUTES OF SURIMI BASED SAUSAGES

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by

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a*	redness
ATP	adenosin tryphosphate
b*	yellowness
C	Celsius
CHO	carbohydrate
cm	centimeter
CMC	carboxymethylcellulose
DTNB	5, 5’-dithio-bis (2-nitrobenzoic-acid)
FPC	fish protein concentrate
Hg	mercury
g	gram
g	gravitational force
h	hour
kDa	kilo Dalton
Kg	kilogram
L*	lightness
M	molarity
mg	milligram
MHC	myosin heavy chain
min	minute
ml	milliliter
mm	millimeter
mM	millimolar
MW	molecular weight

μPi	microphosphate inorganic
N	normality
nm	nanometer
QDA	quantitative descriptive analysis
TEF	total expressible fluid
s	second
SD	standard deviation
SDS-PAGE	sodium dedocyl sulfate polyacrylamide gel electrophoresis
SEM	scanning electron microscopy
SH	sulfhydryl
STPP	sodium trypolyphosphate
TPA	texture profile analysis
V	volt
WHC	water holding capacity
w/v	weight/volume

KESAN PENAMBAHAN HIDROKOLOID DAN KRIO-PERLINDUNGAN YANG BERBEZA KE ATAS SIFAT-SIFAT FIZIKO-KIMIA DAN ATRIBUT SENSORI SOSEJ BERASASKAN SURIMI

ABSTRAK

Tujuan kajian ini dijalankan adalah untuk menentukan kesan penggunaan hidrokoloid dan krio-perlindungan ke atas sifat-sifat fiziko-kimia dan atribut sensori dalam sosej dari surimi. Eksperimen pertama menghasilkan sosej ikan daripada 100% surimi beku (SP00), 50% surimi beku dan 50% tepung surimi (SP50), dan 100% tepung surimi (SP100). Profil analisis tekstur (kekerasan, kepaduan, keanjalan, dan kekenyalan) serta kekuatan gel SP100 lebih rendah ($P < 0.05$) berbanding dengan SP00. Hasil kajian sensori yang menggunakan analisis kuantitatif deskriptif (QDA) menunjukkan bahawa kekerasan, kepaduan, keanjalan, dan kekenyalan untuk SP100 lebih rendah berbanding SP50 dan SP00.

Kajian mengenai kesan hidrokoloid (karboksilmetilselulosa(CMC), guar gum, pektin, konjak, karagenan, alginat, and gelatin ikan) terhadap gel surimi yang dihasilkan daripada tepung surimi menunjukkan bahawa CMC dan alginat telah meningkat kekenyalan masing-masing sebanyak 47% dan 59%. Konjak telah meningkatkan kepaduan (3%), keanjalan (15%), dan kekenyalan (89%). Secara keseluruhan, potensi hidrokoloid untuk meningkatkan kualiti gel tepung surimi pada tahap 0.5% ialah konjak, diikuti oleh CMC dan alginat. Ketiga-tiga hidrokoloid kemudiannya telah ditambahkan kepada sosej ikan. SAalg dan SAkjc mempunyai kekuatan gel yang lebih tinggi (sekitar 26% dan 28%) berbanding SP100. SAkjc telah meningkatkan nilai WHC sekitar 10% lebih tinggi berbanding SP100. SAcmc, SAalg, dan SAkjc mempunyai nilai sensori QDA untuk keanjalan dan kepaduan lebih tinggi dibanding SP100.

Pada tahap akhir kajian ini, krio-perlindungan (sorbitol, laktitol, maltodekstrin, trehalos, polidektros, palatinit, dan sukrosa) telah ditambah sebagai krio-perlindungan semasa menghasilkan tepung surimi. Hasil menunjukkan bahawa tepung surimi yang ditambah krio-perlindungan mempunyai kualiti pembentukan gel (1-2.67%), WHC (±267% lebih tinggi dari kawalan), kekuatan emulsi dan buih yang tinggi. Kadar aktiviti Ca^{2+}–ATPase, kandungan sulfhihidril, dan hasil gel elektroforesis menunjukkan bahawa krio-perlindungan telah berjaya melindung protein daripada denaturasi semasa proses pengeringan. Apabila tepung surimi digunakan dalam formulasi sosej, didapati bahawa krio-perlindungan tersebut telah berjaya meningkatkan keanjalan (42-200%), WHC (22-32%), hasil masakan (5-6%), pengekalan lembapan (5-8%), dan pengekalan lemak (17-48%). Sampel sosej ikan tidak mempunyai sebarang perbezaan signifikan ($P > 0.05$) pada darjah keputihan (10.78-11.56), rupa bentuk (8.94-10.32), rasa ikan (7.12-7.67), kekenyalan (5.36-5.80), kekerasan (8.13-8.78), dan kandungan minyak (6.33-7.34) yang telah dinilai oleh para panel sensori. Bagaimanapun, nilai kemanisan sosej dengan gula kuasa kemanisan yang rendah adalah lebih rendah ($P < 0.05$) secara signifikan berbanding sukrosa.

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ABSTRACT

The aim of this study was to determine effect of different hydrocolloids and cryoprotectants on physicochemical properties and sensory attributes of surimi based sausages. Sausages in first experiment were formulated using 100% frozen surimi (SP00), 50% frozen surimi and 50% surimi powder (SP50), and 100% surimi powder (SP100). The texture profile analysis (TPA) values (hardness, cohesiveness, springiness, and chewiness) and gel strength of SP100 were significantly lower ($P < 0.05$) than those of the SP00. Sensory analysis using a quantitative descriptive analysis (QDA) showed that hardness, cohesiveness, springiness, and chewiness scores of SP100 were lower than those of SP50 and the SP00.

The effect of hydrocolloids (carboxymethylcellulose/CMC, guar gum, pectin, konjac, carrageenan, alginate, and fish gelatin) on surimi gel prepared from surimi powder showed CMC and alginate improved cohesiveness by 47% and 59%, respectively. Konjac improved cohesiveness, springiness, and chewiness by 3%, 15%, 89%, respectively. Overall, the potential hydrocolloid that improved the gel characteristics of surimi powder at level 0.5% were konjac, followed by CMC, and alginate. These three hydrocolloids then were used in sausage formulation. SAalg and SAkjc had higher gel strength (~26 and 28%, respectively) than SP100. SAkjc improved the WHC around 10% relative to SP100. SAcmc, SAalg, and SAkjc had higher QDA scores for springiness and cohesiveness than SP100.

On the last experiment of study, different cryoprotectants (sorbitol, lactitol, maltodextrin, trehalose, polydextrose, palatinit, and sucrose) were added during preparation of surimi powder. Results showed that treated surimi powder had high gel formation (1-2.67%), WHC (±267% higher than control), emulsifying and foaming properties. Ca^{2+}–ATPase activity, SH-content, and gel-electrophoresis results showed that cryoprotectants successfully protected protein against denaturation during drying. When surimi powder were applied in sausage, it was found that cryoprotectants were able to improve springiness (42-200%), WHC (22-32%), cooking yield (5-6%), moisture retention (5-8%), and fat retention (17-48%). The QDA sensory evaluation showed that treated sausage samples had no significant difference ($P > 0.05$) scores for whiteness (10.78-11.56), appearance (8.94-10.32), fish taste (7.12-7.67), chewiness (5.36-5.80), hardness (8.13-8.78), oiliness (6.33-7.34). The QDA score for sweetness of sausages treated with sugar with low sweetening power was significantly lower ($P < 0.05$) than that of sucrose.

CHAPTER 1 INTRODUCTION

1.1 Background

Surimi is a concentrated myofibrillar protein extracted from deboned fish flesh by a washing process with cold water and mixed with cryoprotectants (Park and Lin, 2005). Surimi has excellent functional properties such as high gelling properties, water holding capacity (WHC), emulsion and foaming properties, thus it has been applied widely for making fish derived products, such as kamaboko and fish balls. To maintain its quality, surimi needs to be kept in frozen temperature of –23 to –25^{o}C (Matsumoto and Noguchi, 1992). In addition, surimi still needs to be kept in –25 ^{o}C or below during shipping (Toyoda et al., 1992). This frozen condition of storage and distribution costs are high. Surimi also has moisture content up to 80% which needs high cost for handling distribution and wide space to store.

Surimi powder, the dry form of surimi, offers many advantages compared with frozen surimi, such as ease of handling, more convenient storage at ambient temperature, and its usefulness in dry mixtures (Green and Lanier, 1985). However, drying process can cause denaturation of proteins due to the aggregation of protein when water is removed from the matrix as well as freezing process (Carjaval et al., 2005).

The same sugars and other polyols used as a cryoprotectant in the freezing process in making frozen surimi also can be used in the drying process in making surimi powder (Suzuki, 1981). The term of dryprotectant was used first time by Niki et al. (1992) and Sikorski et al. (1994) for sugars and other polyols in the spray- and freeze-drying process of surimi. Recently, Carjaval et al. (2005) and Shaviklo et al. (2010) used the term of lyoprotectant for production of surimi powder, particularly with freeze-drying method (Carjaval et al., 2005). In this study, the term of cryoprotectant is used for sugar and polyols added in the surimi powder production.

The physicochemical properties of surimi powder have been investigated previously, as has optimization of the drying process (Niki et al., 1992; Huda et al., 2001a; Shaviklo et al., 2010). Huda et al. (2003) showed that freeze-dried surimi powder from threadfin bream (*Nemipterus* spp.) is a potentially useful raw material for gel-based products, such as fish ball. In order to improve gel structure of surimi powder, biopolymers possessing gel-forming ability, such as hydrocolloids, can be added. The reason is because it has been possible to develop a large variety of analogues based on modification of the functional and textural properties of surimi by adding the hydrocolloids (Gómez-Guillén and Montero, 1996). However, there is lack of scientific information about the effect of hydrocolloids to improve gel properties of surimi powder.

Meanwhile, the incorporation of sucrose as a commercial cryoprotectant imparts sweet taste in surimi products, which is not preferred by consumers (Sen, 2005). Sugar with low sweetening power can be an alternative to overcome the problem. The using of sucrose, sorbitol, lactitol, maltodextrin, trehalose, polydextrose and palatinit as cryoprotectant in frozen surimi has been studied recently (Nopianti et al., 2012). Yet, there is no such research study on their ability as a cryoprotectant in making surimi powder.

Since the 1990s, researchers have focused on the application of surimi powder in food products, including rice-fish snacks (Gogoi et al. 1996), fish crackers (Huda et al. 2001b), fish balls (Huda et al. 2003), corn-fish snacks (Shaviklo et al.

2010), and fish cutlet mixes (Shaviklo et al. 2011). Besides, surimi powder has high gel strength and excellent bending capacity (Niki et al. 1992), thus it may be an ideal raw material for fish sausage.

Sausage is a product in which meat flesh is mixed with additives, stuffed into suitable casings, and heat processed (Raju et al., 2003). Fish sausage is a product that sausage manufactures have started producing due to changing consumer preferences toward healthier lifestyles and safer and cheaper foods (Panpipat and Yongsawatdigul, 2008; Nowsad and Hoque, 2009). However, the application of surimi powder in fish sausage has not been studied previously.

The first aim of this study is to analyze the physicochemical properties and sensory attributes of surimi based sausage. Second aim is to measure the effect of hydrocolloids (carboxymethylcellulose/CMC, guar gum, pectin, konjac, carrageenan, alginate, and fish gelatin) on gelling properties of surimi powder surimi based sausage. The last aim of this study is to determine the cryoprotective ability of sugar with low sweetening power (sorbitol, lactitol, maltodextrin, trehalose, polydextrose and palatinit) and sucrose on protein during preparation of surimi powder compared with sucrose and their application in fish sausage.

1.2 Objectives

The main objective of this study is to investigate the physicochemical properties and sensory attributes of surimi based sausage. The specific objectives are:

1. To determine the physicochemical properties and sensory attributes of surimi based sausage from threadfin bream fish (*Nemipterus* spp.)

2. To measure the effect of hydrocolloids on the gelling properties of surimi powder and surimi based sausage
3. To identify the effect of sugar with low sweetening power (sorbitol, lactitol, maltodextrin, trehalose, polydextrose and palatinit) and sucrose on physicochemical properties of surimi powder and their application on fish sausage.