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ARTICLE

Effects of Sucrose Stearate Addition on the Quality Improvement of Ready-To-Eat *Samgyetang* During Storage at 25°C

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Abstract

The effects of sucrose stearate at various concentrations (0.1%, 0.2%, and 0.3%, w/v) on the physico-chemical characteristics of ready-to-eat (RTE) *Samgyetang* were investigated during storage at 25°C for 12 mon. Over the storage duration, the addition of sucrose stearate had no significant effects on the proximate composition of *Samgyetang*, including meat, broth, and porridge, or the hardness and spreadability of the porridge, although it resulted in significantly higher CIE L* values for the porridge. The CIE L* values of *Samgyetang* porridge with added sucrose stearate increased until 9 mon, while the control decreased until 6 mon, and the values for both changed insignificantly thereafter. The breast meat of *Samgyetang* treated with sucrose stearate showed higher percentages of polyunsaturated fatty acid after 3 mon and lower percentages of monounsaturated fatty acid after 6 mon compared to the control ($p<0.05$), while no significant differences were observed with the different sucrose stearate concentrations ($p>0.05$). The overall sensory acceptability scores were higher at sucrose stearate concentrations of 0.2% or 0.3% after 6 mon and at 0.1% after 9 mon compared to those of the control.

Keywords: *Samgyetang,* sucrose stearate, storage, quality characteristics

Introduction

Samgyetang is a popular, healthy chicken soup in Korea, where it is often eaten to supplement nutrients and prevent illness. Conventionally, the commercial ready-to-eat (RTE) *Samgyetang* is made by cooking a whole young chicken together with ginseng, glutinous rice, and various spices and seasonings after packaging in a retort pouch and heating in a retort at 121°C for 50-60 min. However, consumers are often put off by the sight of fat droplets on the broth. Therefore, an advanced technological approach is needed to improve the quality of *Samgyetang* and to reduce the presence of obvious fat droplets on the surface. Furthermore, because the quality of the porridge elements is an essential part of the experience of tasting and enjoying *Samgyetang*, they must be protected from deterioration as much as possible during storage.

The unappealing fat droplets in *Samgyetang* products should be addressed by using an emulsifier that is safe and can reduce the fat droplets' sizes. In this case, the use of sucrose stearate in an appropriate concentration in *Samgyetang* products could be an alternative process to dissolve the fat droplets, as well as to maintain the quality of the porridge in *Samgyetang*.

Sucrose stearate, which is a 'generally recognized as safe (GRAS)' substance, is used as an emulsifier in an extensive range of food applications as well as bakery items, confectionary, beverages, and dairy products as the most fascinating and readily available sucrose ester worldwide (Akoh and Swanson, 1994). Sucrose stearate is a sucrose ester made from a mixture of octa-, hepta-, and hexaesters of sucrose with a wide range (1-18) of hydrophilic-lipophilic balance (HLB) (Hasenhuettl and Hartel, 1997). Sucrose esters with HLBs ranging from 8 to 18 are suitable for oil-in-water (o/w) emulsions with very small droplets, stability, and creamy mouth feels (Whitehurst *et al.,* 2007). Sucrose stearate can be practically used as an emulsifying agent with low toxicity which may be used in food applications (Osipow *et al.,* 1956). Lee *et al.* (1991) have reported that the addition of sucrose esters increases the lightness index, texture, and solubility of starch-based foods in water.

The use of sucrose stearate might be an option for dispersing the fat droplets in the RTE *Samgyetang*, while preserving the porridge quality. Therefore, this study examined the effects of different sucrose ester concentrations on various physico-chemical characteristics of the

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RTE *Samgyetang* during storage.

Materials and Methods

Sample preparation

The RTE *Samgyetang* used for the experiment was manufactured in the Packaging Laboratory of Gangneung-Wonju National University and at the Gangneung Industrial Complex, Korea. The RTE *Samgyetang* samples were then analysed during storage at 25°C for 12 mon. The broth was prepared by boiling water with chicken powder, old broilers, garlic, ginger, chestnut, salt, milk vetch root, pepper, and sugar for 2 h while removing foam and fat droplets from the surface of the broth. Each pouch of *Samgyetang* was made from a Korean broiler chicken (450 g) with the abdominal cavity filled with 100 g of glutinous rice and 100 g of ginseng-garlic-jujube, and then 200 mL of broth was added.

The emulsifier used in our experiment was sucrose stearate (S-1670, Mitsubishi-Kagaku Foods Co., Japan) with a high HLB value (approx. 16). Sucrose stearate was added to the broth in concentrations of 0.1% (T1), 0.2% (T2), 0.3% (T3) (w/v), and mixed thoroughly. The samples were sterilized in a retort (PRS-06-1, Kyonghan, Korea) at 121°C for 65 min under an F_0-value of approximately 8.0 after packaging in a retort pouch consisting of a multilayer plastic film (PET 12 μm/AL 9 μm/PA 15 μm/AL 7 μm/CPP 100 μm). The samples were allocated for experiments at the end of every 3 mon storage period.

Proximate composition

Proximate analysis was performed on the breast meat, broth, and porridge of *Samgyetang* without the skin layer according to the AOAC method (2007). The moisture content of *Samgyetang* was determined by heating the sample at 105°C in a drying oven (KI-012, Kum Hwa Industrial Co., Korea). The crude protein content was measured using a protein content analyser (KjelFlex 360, Buchi, Switzerland) and assessed by the gravimetric method. The fat content was analysed using a fat extractor (Tecator 1043 Extractor Unit, Soxtec System HT, Sweden). The crude ash content was determined by heating samples at 550±10°C for 24 h in a furnace (Wise Therm, Witeg, Germany).

pH value

Ten grams of porridge was added into 40 mL of distilled water and then homogenized at 10,000 rpm for 60 s using a homogenizer (T 18 Ultra-Turrax, IKA, Germany). The pH value of the homogenized sample was measured using a pH meter (Sg2-ELK, Mettler Toledo Co., Ltd., Switzerland). The pH measurement was performed six times in every sample and duplicated per treatment.

Instrumental color

Color changes on the surface of the *Samgyetang* porridge were monitored by measuring the CIE L* value using a color difference meter (CR-400, Konica Minolta Sensing Inc., Japan) as described by Jang and Lee (2012). The colour instrument was calibrated using a white plate (Y=93.7, x=0.3132, and y=0.3192). Illuminant C and a standard 10° observer with a D 65 source light were used for measuring color characteristics. The color of the porridge was measured six times in each sample at different locations.

Texture analysis

The texture of *Samgyetang* porridge was determined using the method reported by Gui and Ryu (2014) with some modifications. A rheometer (Compac-100, Sun Scientific Co., Ltd., Japan) equipped with RDS 2.01 software and adaptor type No. 32 was used to measure the force to compress 3 g of cooked rice in the porridge. The compression probe was set at 20 mm of initial height with the probe speed at 60 mm/min. The texture profile was expressed as hardness (kg/m^2).

Thiobarbituric acid reactive substances (TBARS)

TBARS values were measured to assess lipid oxidation changes according to the method reported by Witte *et al.* (1970). A breast meat sample (20 g) was added to 50 mL of 20% trichloroacetic acid (in 2 M phosphate). The sample was homogenized for 90 s, transferred to a flask, diluted to 100 mL with distilled water, and filtered through No. 1 Whatman filter paper. Thiobarbituric acid (TBA, 0.005 M in distilled water) was then added to the filtrate (5 mL) and resultant mixture was mixed using a vortex mixer (KMC-1300 V, Vision Scientific Co., Ltd, USA) and stored in a dark room for 15 h. Finally, the absorbance of the solution was measured at 530 nm using a spectrophotometer (V-650, Jasco, Japan). The TBARS value was expressed as milligram of malondialdehyde (MDA) per kilogram of meat.

Viscosity

According to the method of Jang and Lee (2012) with slight modifications, apparent viscosity of *Samgyetang* broth was measured using a viscometer (DV-II, Brookfield Eng, USA) equipped with cylindrical RV spindle No. 1 at 20 rpm. Broth samples were sieved using a 350 μm sieve without applying any compulsory physical force for 30 min by maintaining 400 mL of filtrate at 25°C. The apparent viscosity value was expressed as centipoise (cp).

Spreadability

The spreadability of the porridge was measured using the method described by Kim *et al.* (2004). It was analysed by using a PVC pipe (31 mm diameter × 65 mm length). Forty grams of the porridge sample together with 10 mL of broth were heated to 60±5°C after removing any solid particles, including jujube, garlic, and ginseng. Twenty grams of the mixture was poured into the pipe and held for 30 s before measuring the spreading area (mm) on a glass plate.

Fatty acid profiles

Fatty acid profiles of breast meat were investigated using gas chromatography (GC) according to the method of O'Fallon *et al.* (2007). For this measurement, 10 g of a breast meat sample was ground using a blender (Waring Blender, Waring Commercial, USA) and 0.1 g was placed into a screw-cap test tube (Pyrex, Corning Inc., USA). Then, 700 μL of 10 N KOH in water with 5.7 mL of MeOH was added and mixed thoroughly by centrifugation. This tube was incubated at 55°C for 1.5 h with vigorous shaking every 20 min for 5 s before cooling in a cold water bath for 10 min, then 3 mL of hexane was added and mixed for 3 min using a vortex mixer (KM C-1300V, Vision Scientific Co., Ltd., Korea) in a 50 mL centrifuge tube for 5 min at 2300 rpm. The top hexane layer containing methylated fatty acids was used for the GC analysis. The fatty acid composition was measured by using a GC (US/HP 6890, Agilent Tech., USA) equipped with a mass selective detector (Inert 5973, Agilent Tech., USA) and a DB-WAX capillary column (30 m × 0.25 mm × 0.25 μm) (J&W Scientific, USA). The initial oven temperature was 100°C, which was retained for 2 min and subsequently increased to 250°C at a rate of 5°C/min, and then held for 20 min. Helium was used as the carrier gas at a flow rate of 7.9 mL/min with the column head pressure at 404.93 mm Hg. Both the injector and the detector temperatures were set at 250°C and the split ratio was 5:1 (v/v).

Sensory evaluation

Before the sensory evaluation, all the packaged samples were first warmed up to 85°C in boiling water for 15 min. The panel consisted of 10-11 trained faculty members and students. They evaluated changes in the quality characteristics of *Samgyetang* during storage, including colour, off-odour, texture of breast meat, flavour, fat distribution on broth, softness of rice, and fatty mouth-feel, which comprise the overall sensory acceptabiliy. The panelists evaluated the samples according to the following scale: 9 =extremely like, 7=like, 5=moderately like, 3=dislike, and 1=extremely dislike.

Statistical analysis

All data were analysed by one way analysis of variance using the SPSS (ver. 14.0) statistical package. The means of the data in each sucrose stearate treatment were compared using Duncan's multiple range tests to determine the significance at $p<0.05$.

Results and Discussion

Proximate composition

As shown in Table 1, for breast meat, broth, and porridge of *Samgyetang*, there were no significant differences observed in the proximate composition between the control and the treatments ($p>0.05$). The proximate compositions of moisture content of broth in all treatments were found to be insignificant ($p>0.05$) at 94.07-94.10%. The moisture content of *Samgyetang* broth in all the samples showed higher values than those of a prior experiment by Suzuki and Rhim (2000), in which it was measured at 84.5%. This might be because the different kinds of ingredients used in the *Samgyetang* manufacturing process resulted in different moisture contents. A similar result was also reported by Irawati *et al.* (2007), who showed different proximate compositions for two kinds of traditional chicken soup because of the use of different ingredients in the broth.

In all the samples investigated for this experiment, the protein content of breast meat was 27.60% and the fat content was 1.70%; no significant differences were observed between the control and the treatments ($p>0.05$). These results showed that the protein and fat contents in this experiment were higher than those reported for two previous experiments by Wattanachant *et al.* (2004) and Ali *et al.* (2007), which were measured at 20.59%, 22.04%, 0.68%, and 1.05%, respectively. These results might be related to different chicken types, chicken ages, and meat composition. However, no significant difference was evident in the proximate composition in this study. This result might be attributed to the fact that the added concentra-

Table 1. Proximate composition of RTE *Samgyetang* with different concentrations of sucrose stearate

Proximate composition	Treatments[1)]			
	C	T1	T2	T3
Moisture (%)[NS]				
Breast meat	70.20±2.30	70.20±2.00	70.20±2.30	70.20±1.93
Broth	94.10±2.05	94.08±2.01	94.08±2.02	94.07±2.03
Porridge	87.27±1.10	87.28±1.20	87.27±1.10	87.27±1.10
Protein (%)[NS]				
Breast meat	27.60±0.62	27.60±0.62	27.60±0.61	27.60±0.61
Broth	3.26±0.61	3.27±0.61	3.25±0.54	3.26±0.58
Porridge	3.06±0.51	3.07±0.61	3.05±0.51	3.06±0.52
Fat (%)[NS]				
Breast meat	1.70±1.02	1.70±0.11	1.70±0.53	1.70±0.73
Broth	2.01±0.82	2.00±0.72	2.03±0.72	2.03±0.70
Porridge	1.30±0.35	1.20±0.44	1.20±0.40	1.24±0.42
Ash (%)[NS]				
Breast meat	0.50±0.05	0.50±0.04	0.50±0.01	0.50±0.01
Broth	0.63±0.06	0.65±0.05	0.64±0.05	0.64±0.04
Porridge	0.50±0.03	0.50±0.04	0.50±0.04	0.50±0.02
Carbohydrate (%)[NS]				
Porridge	7.92±0.06	7.91±0.08	7.94±0.04	7.93±0.05

Data are presented as Means±SD (Standard deviation, *n*=4).
[NS] Not significantly different (p>0.05).
[1)]Sucrose stearate concentration: 0% (C), 0.1% (T1), 0.2% (T2), 0.3% (T3) (w/v).

tion of 0.1-0.3% sucrose stearate is very low with respect to the broth volume (~200 mL) of the *Samgyetang*.

pH value

Table 2 shows the pH changes of porridge during storage at 25°C, which increased slightly from 6.2 to 6.3 (C and T1) and 6.4 (T2 and T3) at 3 mon and decreased to 6.1 after 12 mon in all the samples. The increment in the pH values of porridge after 2 mon was also observed in a prior experiment by Jang and Lee (2012) for an RTE ginseng chicken porridge in the range 6.49-6.50. A decreasing tendency of the pH value during storage of porridge products has also been reported by Ocheme (2007), who made this observation in *Pennisetum glaucum* porridge packaged with PE film during 3 mon storage. It also has been reported that the pH value of the porridge decreases by the formation of lactic acid from *Lactobacillus* spp. through starch fermentation (Onyango *et al.*, 2000). In the present study, the microbes did not grow under the retorted conditions of RTE *Samgyetang*. Therefore, the oxidation of lipids from residual oxygen in the package is likely the main reason for the pH decrement (Jang and Lee 2012; Jin *et al.*, 2002; Liu *et al.*, 2009).

Instrumental color

The changes of CIE L* value (lightness) in the *Samgyetang* porridge are presented in Table 2. The CIE L* values of the RTE *Samgyetang* porridge increased with the addition of sucrose stearate. The CIE L* value of porridge is an important factor affecting the quality and consumer appeal. In this study, the lightness of the porridge control sample decreased from 63.1 at 0 mon to 61.8 at mon 6, and increased with sucrose stearate treatments from 62.9 (T1), 62.9 (T2), and 62.8 (T3) at mon 0 to 71.4, 71.4, and 70.8 at 9 mon, respectively, and remained insignificant thereafter. These results were in agreement with the study by Park *et al.* (2012), who showed that the lightness of milled rice without any emulsifier treatment decreased to 37.7 after 2 mon of storage at 20°C. Lai (2002) also showed a positive effect of emulsifier which increased the lightness value of rice pasta. Lee *et al.* (1991) also showed that sucrose stearate can increase the lightness of starch-based foods.

Texture analysis

The hardness of the porridge in all the samples decreased over the storage duration from 7.8 to 4.6 kg/m^2 with no significant differences (p>0.05) between the control and the treatments. These results were in accordance with those reported by Jang and Lee (2012), who showed the texture decrement in the RTE ginseng chicken porridge during storage at 25°C. The hardness of the rice porridge

Table 2. Changes in various physico-chemical and sensory characteristics of RTE *Samgyetang* during storage depending on different concentrations of sucrose stearate

Parameters	Treatments[1)]	Storage time (mon)				
		0	3	6	9	12
Hardness of porridge (kg/m^2)	C	7.7±0.08^{A}	7.4±0.11^{B}	6.9±0.08^{C}	6.0±0.06^{D}	4.8±0.11^{E}
	T1	7.7±0.10^{A}	7.4±0.04^{B}	6.9±0.08^{C}	5.9±0.06^{D}	4.7±0.10^{E}
	T2	7.7±0.10^{A}	7.5±0.10^{B}	6.8±0.08^{C}	5.8±0.05^{D}	4.7±0.10^{E}
	T3	7.8±0.04^{A}	7.6±0.03^{B}	6.6±0.05^{C}	5.6±0.04^{D}	4.6±0.06^{E}
pH of porridge	C	6.2±0.02^{B}	6.3±0.02^{A}	6.2±0.02^{B}	6.2±0.03^{B}	6.1±0.06^{C}
	T1	6.2±0.02^{B}	6.3±0.03^{A}	6.2±0.02^{B}	6.2±0.03^{B}	6.1±0.08^{C}
	T2	6.2±0.03^{B}	6.4±0.02^{A}	6.2±0.03^{B}	6.2±0.02^{B}	6.1±0.04^{C}
	T3	6.2±0.04^{B}	6.4±0.03^{A}	6.2±0.02^{B}	6.1±0.04^{C}	6.1±0.04^{C}
Viscosity of broth (cp)	C	7.5±0.51^{B}	8.7±0.56^{A}	8.8±0.99^{A}	8.9±0.64^{aA}	8.8±0.44^{A}
	T1	7.5±0.52^{B}	8.5±0.50^{A}	8.6±0.71^{A}	8.7±0.52^{bA}	8.8±0.48^{A}
	T2	7.5±0.52^{B}	8.5±0.52^{A}	8.6±0.53^{A}	8.7±0.38^{bA}	8.8±0.46^{A}
	T3	7.5±0.52^{B}	8.5±0.53^{A}	8.6±0.53^{A}	8.7±0.53^{bA}	8.8±0.46^{A}
Spreadability of porridge (mm)	C	1.5±0.06^{D}	2.5±0.04^{C}	2.7±0.04^{B}	2.8±0.02^{B}	3.1±0.02^{A}
	T1	1.5±0.06^{D}	2.4±0.00^{C}	2.6±0.04^{B}	2.8±0.02^{B}	3.2±0.02^{A}
	T2	1.5±0.06^{D}	2.4±0.00^{C}	2.6±0.04^{B}	2.8±0.02^{B}	3.1±0.04^{A}
	T3	1.5±0.06^{D}	2.4±0.00^{C}	2.6±0.04^{B}	2.8±0.02^{B}	3.2±0.04^{A}
CIE L* value of porridge	C	63.1±0.30^{A}	64.7±0.34^{A}	61.8±0.30^{bB}	60.1±0.34^{cB}	59.8±0.16^{bB}
	T1	62.9±0.75^{D}	64.6±0.43^{C}	68.3±0.17^{abB}	71.4±0.86^{aA}	71.2±0.24^{aA}
	T2	62.9±0.25^{D}	64.6±0.48^{C}	68.3±0.29^{abB}	71.4±0.21^{aA}	71.4±0.36^{aA}
	T3	62.8±0.41^{D}	64.8±0.32^{C}	69.5±0.30^{aB}	70.8±0.27^{bA}	71.1±0.16^{aA}
TBARS (mg MA/kg meat)	C	0.44±0.00^{E}	0.60±0.01^{aD}	0.87±0.01^{aC}	0.99±0.00^{aB}	1.42±0.01^{aA}
	T1	0.44±0.00^{E}	0.59±0.01^{bD}	0.86±0.00^{bC}	0.98±0.01^{bB}	1.41±0.00^{bA}
	T2	0.44±0.00^{E}	0.59±0.01^{bD}	0.86±0.00^{bC}	0.98±0.01^{bB}	1.41±0.00^{bA}
	T3	0.44±0.01^{E}	0.58±0.00^{cD}	0.86±0.00^{bC}	0.96±0.00^{cB}	1.41±0.01^{bA}
Overall sensory acceptability[2)]	C	8.9±0.74^{A}	8.0±0.70^{aB}	7.4±0.78^{cC}	6.3±0.46^{dD}	5.0±0.46^{bE}
	T1	8.9±0.62^{A}	8.0±1.04^{aB}	7.4±1.13^{cC}	6.4±0.93^{cD}	5.3±0.38^{aE}
	T2	8.9±0.74^{A}	8.0±1.16^{aB}	7.5±0.74^{bC}	6.7±1.16^{aD}	5.4±0.27^{aE}
	T3	8.9±0.71^{A}	7.9±1.31^{bB}	7.6±1.31^{aC}	6.6±0.99^{bD}	5.3±0.26^{aE}

$^{a\text{-}d}$Values (Means±SD) with different superscripts in the same column differ significantly (p<0.05).
$^{A\text{-}E}$Values (Means±SD) with different superscripts in the same row differ significantly (p<0.05).
[1)]Refer to Table 1.
[2)]Sensory scores: 9 = extremely like, 7 = like, 5 = moderately like, 3 = dislike, and 1 = extremely dislike.

decreased over the storage duration. This might be related to the different amylopectin and amylose contents of glutinous rice types which affect the rheological properties of rice, as reported by Syahariza *et al.* (2013). The results indicate that the internal structure of cooked rice grains can change depending on the amylose and amylopectin contents of the sample. Variation of the concentration of sucrose stearate in the *Samgyetang* broth did not significantly affect the samples; this could be because the rice porridge in the *Samgyetang* is always immersed in the broth during storage. Thus, broth immersion has a greater impact on the texture of rice porridge than sucrose stearate. Gujral and Sodhi (2002) and Sai Manohar *et al.* (2011) supported this study and concluded that the ratio of solid to water in wheat-porridge products could affect the texture characteristics.

Viscosity

In this experiment, the viscosity of the *Samgyetang* broth increased at 3 mon (p<0.05) and remained insignificant until 12 mon of the storage period (p>0.05). These results were supported by Jang and Lee (2012), who observed the viscosity increment in the RTE ginseng chicken porridge during storage at 25°C. This phenomenon can be explained by the gelatinization mechanism of starch resulting in the swelling and hydration of the rice component into the broth of *Samgyetang*. The process of starch gelatinization is characterized by the leaching of amylase and swelling of the starch granules (Lai and Kokini, 1991). The mechanism observed in this experiment was also reported by Srikaeo and Sopade (2010), who indicated that rice components can be the cause of the viscosity increment of instant jasmine rice porridge.

Sucrose stearate has been used as an emulsifier, and thus could increase the apparent viscosity of rice flour. Meng *et al.* (2014) also found that the sucrose stearate in rice flour reduces the pseudoplasticity of rice flour gel starch molecule immobilization, which results in higher viscosity. However, in this study, sucrose stearate did not affect the viscosity except for the sample stored for 9 mon, which had a lower viscosity than the control group. This might be related to the ability of sucrose stearate to produce a smooth porridge texture in the broth after extended storage time resulting in a less viscous broth than the control group. Despite, the viscosity at the end of the storage period was not significantly different (p>0.05).

Spreadability

The spreadability of porridge samples tended to increase continuously throughout the storage duration, irrespective of the sample type. The spreadability of the porridge was maintained in the range 1.5-3.1 (control), 1.5-3.2 (T1), 1.5-3.1 (T2), and 1.5-3.2 (T3). The spreadability results were not significantly different between the control and the sucrose stearate treatments (p>0.05). From this observation, it is assumed that sucrose stearate did not exert any significant effects on the properties of *Samgyetang* porridge in terms of spreadability. The differences might be caused by other factors such as water in the broth, which had a larger effect on the spreadability process compared with the sucrose stearate additions. Suzuki and Rhim (2000) showed that the *Samgyetang* broth, in 39.4%, comprised the second highest ingredient of the *Samgyetang* parts compared to solid ingredients (chicken tissue, sticky rice, and garlic) which accounted for 46.3%. A similar result was observed by Briffaz *et al.* (2013), who showed that the swelling of rice starch in the rice cooking process was related to the water transport mechanism in cooked-rice samples.

Thiobarbituric acid reactive substance (TBARS)

As shown in Table 2, the samples treated with 0.1-0.3% sucrose stearate had lower TBARS values after 3 mon, and especially T3 samples maintained the lower TBARS values than those of the other samples at 3 and 9 mon (p< 0.05). McMillin (2008) reported that TBARS could be used as a strong objective predictor of the rancidity of meat products. Skibsted *et al.* (1998) also reported that the lipid oxidation, oxygen concentration, and antioxidants could be the main factors that affect rancidity.

Sucrose stearate is known to be effective at stabilizing o/w emulsions, which is necessary for delaying the oxidation process of foodstuffs (Berton *et al.*, 2012). Thus, the reduced lipid oxidation of the samples with added sucrose stearate may be due to its antioxidant activity. From this perspective, it is assumed that the addition of 0.3% sucrose stearate to the broth resulted in higher antioxidant activity in the *Samgyetang* at 3 and 9 mon which results in lower TBARS values than obtained using the other treatments. Moreover, Nam and Ahn (2003) reported that raw turkey meat with a TBARS value of 1 mg MDA/kg or higher became to produce rancid odour. In our study, the TBARS values of the samples at 12 mon ranged from 1.41 to 1.42 mg MDA/kg, which indicates a slight rancidity.

Table 3. Fatty acids profiles of breast meat of RTE *Samgyetang* during storage depending on different concentrations of sucrose stearate

Fatty acid	Storage time (mon)					
	Treatments[1)]	0	3	6	9	12
SFA (%)	C	$34.72±2.01^{E}$	$36.80±1.97^{aD}$	$37.23±1.68^{C}$	$38.21±2.42^{aB}$	$39.68±2.20^{A}$
	T1	$34.73±2.04^{E}$	$36.00±1.84^{bD}$	$37.82±1.80^{C}$	$38.45±2.38^{aB}$	$39.48±2.52^{A}$
	T2	$34.72±2.08^{E}$	$36.10±1.98^{bD}$	$37.45±1.84^{C}$	$38.82±2.34^{aB}$	$39.51±2.00^{A}$
	T3	$34.66±1.68^{E}$	$36.30±1.02^{bD}$	$37.21±1.04^{C}$	$37.31±1.63^{bB}$	$39.43±2.38^{A}$
MUFA (%)	C	$43.70±2.01^{E}$	$46.60±1.97^{D}$	$51.83±2.80^{aC}$	$53.86±2.66^{aB}$	$57.60±2.48^{aA}$
	T1	$43.74±2.00^{E}$	$46.30±1.95^{D}$	$47.48±2.84^{bC}$	$51.83±2.82^{bB}$	$57.32±2.47^{bA}$
	T2	$43.72±1.98^{E}$	$46.20±1.94^{D}$	$48.43±2.84^{bC}$	$51.40±2.64^{bB}$	$57.27±2.49^{bA}$
	T3	$43.76±1.96^{E}$	$46.30±1.98^{D}$	$48.69±2.92^{bC}$	$50.28±2.60^{bB}$	$57.22±2.42^{bA}$
PUFA (%)	C	$21.54±0.38^{A}$	$16.60±0.40^{bB}$	$10.94±0.24^{bC}$	$7.93±0.80^{bD}$	$2.72±2.48^{bE}$
	T1	$21.53±0.40^{A}$	$17.70±0.44^{aB}$	$14.70±0.28^{aC}$	$9.72±0.88^{aD}$	$3.20±2.51^{aE}$
	T2	$21.56±0.38^{A}$	$17.70±0.54^{aB}$	$14.12±0.22^{aC}$	$9.77±0.60^{aD}$	$3.22±2.43^{aE}$
	T3	$21.64±0.20^{A}$	$17.40±0.36^{aB}$	$14.10±0.28^{aC}$	$9.99±0.80^{aD}$	$3.35±2.48^{aE}$

$^{a-d}$Values (Means±SD) with different superscripts in the same column differ significantly (p<0.05).

$^{A-E}$Values (Means±SD) with different superscripts in the same row differ significantly (p<0.05).

[1)] Refer to Table 1.

Fatty acid profiles

Table 3 shows the changes in the fatty acid profiles of the breast meat of *Samgyetang*. Park *et al.* (2003) reported that other ingredients such as ginseng, jujube, and garlic could also decrease the lipid oxidation in *Samgyetang*. However, the proportion of saturated fatty acid (SFA) and monounsaturated fatty acid (MUFA) in breast meat significantly increased, while that of polyunsaturated fatty acid (PUFA) significantly decreased throughout the storage period (p<0.05). This might be attributed to the oxidative changes of unsaturated fatty acid to saturated fatty acid. Alina *et al.* (2012) reported that SFA and MUFA in chilled chicken sausages increased until 3 wk of storage duration, while PUFA decreased. A similar result was reported by Özden (2005), who showed the increment of SFA and MUFA and also the decrease of PUFA with a storage period of 120 d in marinated food.

Compared with the control, the samples treated with sucrose stearate showed a higher percentage of PUFA at 3 mon and thereafter, and lower percentages of MUFA after 6 mon compared to the control (p<0.05), while no significant differences were observed with the different sucrose stearate concentrations (p>0.05). Moreover, a lower percentage of SFA was observed at 3 mon for the samples treated with sucrose stearate and at 9 mon for the T3 samples than the control group. This might be because the addition of sucrose stearate prevented the oxidation of lipids, which changed the unsaturated fatty acid to saturated fatty acid. Duh *et al.* (1999) showed that soybean oil in an aqueous solution with a sucrose ester emulsifier addition was more stable than without emulsifier, especially its docosahexaenoic acid (DHA)/omega-3 fatty acid content. Bou *et al.* (2004) reported that the saturation of fatty acids is related to lipid oxidation and rancidity, which could affect the sensory values and consumer acceptability of chicken meat.

Sensory evaluation

The overall sensory acceptability of *Samgyetang* decreased during storage at 25°C; however, the T1 samples showed higher scores after 9 mon and the T2 and T3 samples after 6 mon than the control. These results indicated that sucrose stearate was effective in maintaining the sensory quality of *Samgyetang* during an extended storage period. As reported by Akoh and Swanson (1994), sucrose stearate was able to emulsify and reduce the fat droplets. The effectiveness of sucrose ester to emulsify the fat droplets on food products was also demonstrated by Neta *et al.* (2012), who reported the ability of sucrose ester to emulsify fat and coconut oil with stable emulsions. Another result showed that the sponge cake added with sucrose stearate resulted in increased volume and tenderness, and improved texture (Pierce and Walker, 1987). Despite the fact that the overall sensory acceptability scores of treated samples were higher than those of the control with the extension of storage period, panelists detected a slight sour taste from the treated samples. This sour taste might negatively affect the overall level of sensory acceptability from what it ought to be.

Conclusion

This study investigated the quality of RTE *Samgyetang* by adding different sucrose stearate concentrations during storage at 25°C. The results showed that the addition of sucrose stearate could maintain the CIE L* values of porridge, as well as the TBARS, MUFA, and PUFA levels of the RTE *Samgyetang* during storage without affecting the hardness and spreadability of the porridge or the proximate composition. Although a slight sour taste was detected from the treated samples after prolonged storage, they showed lower TBARS, SFA, and MUFA values, which might impart better sensory quality to the RTE *Samgyetang* throughout the storage duration than those of the control group. Further research is needed to understand the reason responsible for the occurrence of the sour taste from the samples treated with sucrose stearate after extended storage durations.

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