Changes in quality characteristics of ready-to-eat ginseng chicken porridge during storage at 25℃

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Abstract- **Ready-to-eat (RTE) chicken porridge was prepared with chicken breast, chicken broth, and other ingredients (ginseng, glutinous rice, chestnut, and jujube) together with various spices and seasonings. The product was heated in a retort at 121℃ with an F-value of approximately 4.0 after being packaged in a multilayer, gas-tight plastic tray (PP/EVOH/PP) with top film (PET/PA/EPL). The changes in various quality characteristics were investigated at four week intervals during 28 weeks' storage at 25℃. Over the storage period, counts of total aerobes, total aerobic thermophiles, *Clostridium spp*., and anaerobic spore former were not detected above 10^1/g (detection limit). The viscosity increased sharply from 775 cp at day 0 to 2,205 cp after four weeks and steadily increased to 3,033 cp until 16 weeks, and thereafter decreased slightly. The values for residual oxygen concentration in the tray, pH, and gelatinization degree tended to decrease with storage time, namely from 9.9%, 6.49, and 100% initially to 5.7%, 6.05, and 44.1% at week 28, respectively. TBARS values increased from 0.46 initially to 0.95 mg MA/kg after 28 weeks. In terms of color changes during storage, the samples showed slightly increased Hunter L, b, chroma, and *Δ*E values until week 20, but thereafter did not increase significantly. The sensory scores for odour, texture, and flavour were evaluated below 5.0 (marketability level) after 28 weeks of storage. Based on sensory evaluation, it could be concluded that retorted RTE *ginseng* chicken porridge could remain marketable for at least 24 weeks at 25℃.**

Keywords- **Ginseng chicken porridge, retort, storage quality**

I. INTRODUCTION

Today, consumers are showing a preference for purchasing healthy and functional foods. For this reason, ready-to-eat (RTE) meat products are increasingly being chosen by consumers, reflecting modern lifestyle requirements for fast and convenient food preparation. Ginseng, *Panax ginseng*, is a well known medicinal herb containing various multifunctional ingredients recognized to provide tonic, restorative, and health promoting effects in the diet. Traditionally, in Korea, diverse foods are prepared together with Ginseng. For instance, *Samgye-tang*, a popular Korean traditional chicken soup containing ginseng, is known as one of the healthiest and most invigorating foods in Asia. From old times, Chinese medicine has recommended an intake of rice porridge including various herbal medicines as a precautionary measure for disease prevention [1]. In Korea, ginseng chicken porridge often features in the diet of the sick and elderly, and as a breakfast meal because it is healthy, nutritious, and easily digestible. According to the traditional recipe, sliced chicken, glutinous rice, ginseng, and spices are fully boiled in chicken broth to prepare ginseng chicken porridge. However, the time and effort needed to prepare ginseng chicken porridge at home, make this dish impractical in terms of modern diet and lifestyle expectations for speed and convenience. For this reason, there is a place in the market for a product which can be simply, conveniently and quickly microwaved or immersed in hot water to be made ready to serve. In this study, we have developed a RTE type of retorted ginseng chicken porridge packed in a gas tight multilayer plastic tray and top film, and investigated the changes of various microbiological and physico-chemical qualities characteristics during storage at 25℃.

I. MATERIALS AND METHODS

A. Sample preparation and experimental design

For making broth, onion, garlic, ginger, chicken extract powder, tapioca starch, and table salt were mixed in tap water and boiled for 2 hours. While boiling the broth, foam and oil from the chicken were occasionally removed. Glutinous

rice was previously soaked in tap water for 6 hrs. Several sliced chicken breasts (ca. 10 g) from Korean mini-broiler type chicks bred for 35 days, glutinous rice (ca. 30 g), and other ingredients (ginseng, chestnut, and jujube) weighing 3 g in total were put into the multilayer plastic tray (PP/EVOH/PP 482/36/482 ㎛, oxygen permeability: 0.2 cc/dm^2·day·atm). Then, 150 mL of hot chicken broth (at ca. 85°C) was poured over them. The tray was covered with a top film (PET/PA/EPL 12/15/50, oxygen permeability: 0.6 cc/dm^2·day·atm) and heat-sealed using an automatic packaging machine (R-7000, Multivac, UK). Packaged samples were then sterilized in a retort (RE-HJ-600S, Hyupjin machine, Korea) under the F-value of 4.0. The products were stored at 25°C for up to 28 weeks and taken periodically for testing every 4 weeks.

B. Methods

Proximate composition of samples was analyzed according to the AOAC method [2]. The carbohydrate content was calculated by subtracting the percentages of moisture, crude protein, crude fat, and crude ash from 100 percent. For inoculating and counting total colonies, standard-I agar (Merck, Germany) was used. However, 3M agar (U.S.A) was used in parallel in order to count the colonies lower than 2 log cfu/g. Total anaerobic thermophiles and *Clostridium spp*. were enumerated using SPS agar (Merck, Germany). Inoculation, incubation, and colony counting methods were followed according to the Lee, Lee & Yoon method [3]. pH was measured by inserting a spear type electrode directly into the porridge using a pH meter (SG2-ELK, Mettler Toledo Co., Ltd., Switzerland). Changes in the TBARS (thiobarbituric acid reactive substances) were measured to assess lipid oxidation according to the method of Witte, Krause, and Baile [4]. Gelatinization percent value was measured using spectrophotometer at the 530 nm wavelength on the 15 mL supernatant after centrifuging with a speed of 2,000 x g/30 min in a centrifuge (Mega21, Hanil science industrial, Korea) of dispersed samples which was obtained by adding distilled water to the freeze-dried samples. The viscosity of this filtrate was measured using a Viscometer (DV-Ⅱ, Brookfield Eng., USA) attached with the LV spindle No. 6. Oxygen concentration in the headspace of the tray was monitored using a gas chromatography (7890A, Agilent Technologies, Germany). The conditions for the gas analysis are shown in Table 1. For measuring color, five porridge samples were strained through a 400 ㎛ mesh sieve without applying any force for 60 min. The filtrate was transferred to a 250 mL beaker and its aliquot was measured for colour parameters including Hunter L^* (lightness), a^* (redness), and b^* (yellowness) values using a colormeter (CR-3500d, Minolta Co., Japan). ΔE, Hue and chroma value were express as $\Delta E^*_{ab} = [(L^*_1 - L^*_2)^2 + (a^*_1 - a^*_2)^2 + (b^*_1 - b^*_2)^2]^{0.5}$, $h^*_{ab} = \tan(b^*/a^*)^{-1}$ and $C^*_{ab} = (a^{*2}+b^{*2})^{0.5}$, respectively.

Table 1. Conditions of gas chromatography for gas analysis

Column	Carboxen-1000 (Supelco)
Detector	TCD
Oven temp.	Maintained at 30°C for 7 minutes and rise 10°C to 300°C /min
Carrier gas	He (35 psi, total flow 50 mL/min)
Injection	100 μL, 30°C

A trained, 8-10 member panel composed of faculty member and students of Gangneung-Wonju University evaluated porridge samples for its colour, off-odour, texture, and flavour using a 9-point hedonic scale (9: most acceptable, 1: least acceptable). Data were analyzed using the SPSS (Ver. 14.0) statistical package. Furthermore, Duncan's multiple range test was used to compare means and significance which was established at $P < 0.05$.

II. RESULTS AND DISCUSSIONS

Table 2 shows a proximate composition of ginseng chicken porridge. The moisture, crude protein, crude fat, crude ash, and carbohydrate contents were approximately 83.3, 6.6, 1.6, 0.5, and 7.0 percent, respectively. According to the microbiological analysis on the ginseng chicken porridge, total aerobes, aerobic thermophiles, anaerobic spore formers, and *Clostridium spp*. were not detected above the detection limit ($<10^1$/g) over the storage period (data not shown). Table 3 shows the changes in some physical parameters of samples during storage at 25℃

Table 2. Proximate composition of ready-to-eat (RTE) *ginseng* chicken porridge (Unit: %)

Ingredient	Content
Moisture	84.34
Crude protein	6.56
Crude fat	1.62
Crude ash	0.51
Carbohydrate	6.97

pH values decreased significantly with the extension of storage from 6.49 initially to 6.05 after 28 weeks ($p<0.05$). TBARS values increased significantly from 0.46 mg MA/kg at week 0 to 0.95 at week 28 which reflects the gradual oxidation occurring in the tray package over the storage period. The increase of TBARS values during storage can be explained by the observation of oxygen ratio in the package. This result is supported by the findings that the gelatinization value of pine nut porridge also decreased as storage was prolonged [5]. The decrease of gelatinization of added rice to the porridge can be explained as a process of retrogradation of rice resulting in the quality loss of boiled rice. Lee [6] reported the decrease of gelatinization was induced by the increasing hydrogen linkage of starch molecules in the colloid solution formed by gelatinization as storage time extended. The viscosity of ginseng chicken porridge was initially 775 cp however it increased dramatically to 2,205 cp after 4 weeks and then gradually to 3,433 cp till the week 16, and thereafter decreased continually to 2,566 cp. The increase of viscosity in the initial phase can be explained by the dissolution of constituents of boiled rice such as starch and glucose etc. in the broth phase. However, the continual degradation of starch to glucose with the extension of time might result in a slight decrease of viscosity [7]. The oxygen ratio in the package demonstrated that oxygen might have existed in the package from the beginning of storage, sufficiently to induce lipid oxidation, even though it diminished gradually from 10.8% initially to 5.7% after 28 weeks. The gelatinization value of porridge decreased significantly by prolonging the storage ($p<0.05$).

Table 4 shows the changes in the colour parameters of ginseng chicken porridge samples during storage at 25℃. Hunter L, b, and chroma values tended to increase with the extension of storage time, while a value decreased. Based on the color difference confirmed by the changes in the ΔE value, the color changes seemed to take place apparently between week 16 and week 20, however the changes in the later phase of storage time (i.e. after 20 weeks) became less dominant. The sensory attributes including colour, off-odour, texture, and flavour of ginseng chicken porridge samples during storage at 25℃ decreased with storage time. After 28 weeks, the sensory scores for the off-odour, texture, and flavour were rated as 4.9, 4.4, and 4.9, which were below the limit value of marketability (5.0 point).

Table 3. Changes in the pH, thiobarbituric acid reactive substances (TBARS), gelatinization, viscosity, oxygen ratio of ready-to-eat (RTE) *ginseng* chicken porridge retorted under the F-values of 4.0 packaging in a multilayer tray during storage at 25℃

Storage time (weeks)	pH	TBARS (mg malonalde-hyde/kg)	Gelatin-ization (%)	Viscosity (Centi-poise)	Oxygen ratio (%)
0	6.49^{B}	0.46^{H}	100.0^{A}	775^{G}	10.8^{A}
4	6.53^{A}	0.50^{G}	75.8^{B}	2025^{F}	9.9^{A}
8	6.50^{B}	0.55^{F}	58.1^{C}	2742^{D}	8.9^{B}
12	6.49^{B}	0.60^{E}	50.3^{D}	3001^{C}	8.6^{BC}
16	6.37^{C}	0.72^{D}	47.9^{E}	3433^{A}	7.6^{C}
20	6.32^{D}	0.82^{C}	45.2^{F}	3217^{B}	6.7^{D}
24	6.16^{E}	0.90^{B}	44.5^{G}	2958^{CD}	6.2^{DE}
28	6.05^{F}	0.95^{A}	44.1^{G}	2566^{E}	5.7^{E}

$^{A-H}$: Means with different letters with a column of each storage period are significantly different ($P<0.05$).

Table 4. Changes in the color parameters (L*, a*, b*, *Δ*E, hue, and chroma) of ready-to-eat (RTE) *ginseng* chicken porridge retorted under the F-values of 4.0 packaging in a multilayer tray during storage at 25℃

Storage time (weeks)	Color parameters					
	L^{*}	a^{*}	b^{*}	ΔE	Hue	Chroma
0	39.4^{D}	-1.6^{D}	1.1^{E}		0.6^{D}	1.9^{G}
4	40.7^{C}	-1.4^{A}	1.1^{E}	1.3^{E}	0.7^{C}	1.6^{H}
8	42.1^{B}	-1.5^{B}	2.1^{B}	2.9^{C}	1.0^{A}	3.3^{D}
12	40.8^{C}	-1.6^{C}	1.7^{D}	1.5^{D}	0.8^{B}	2.7^{F}
16	42.9^{B}	-1.7^{D}	1.8^{C}	3.6^{B}	0.8^{B}	3.1^{E}
20	44.9^{A}	-2.0^{E}	2.1^{B}	5.6^{A}	0.8^{B}	4.2^{C}
24	44.8^{A}	-2.1^{F}	2.2^{A}	5.5^{A}	0.8^{B}	4.6^{B}
28	44.8^{A}	-2.2^{G}	2.2^{A}	5.5^{A}	0.8^{B}	4.8^{A}

$^{A-H}$: Same as in Table 3.

III. CONCLUSIONS

As well as expecting functional and healthy ingredients in their diet, modern consumers tend to prefer dishes which are fast and convenient to prepare. In this regard, a variety of rice porridge dishes containing various ingredients are now

regularly retailed in Asian markets. Ready-to-eat ginseng chicken porridge, a traditional, healthy Korean dish, was manufactured and packaged in a gas tight multilayer plastic film, and subsequently sterilized. Products stored at 25℃ demonstrated the ability to maintain their marketable quality until 24 weeks. Despite deterioration in the quality of the chicken porridge involving a weakening of the texture of the boiled rice and sliced chicken meat, as well as off-odour and off-flavour after prolonged storage, ginseng chicken porridge was not found to pose any microbiological hazard when distributed at room temperature.

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