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THE EFFECT OF AN ADDITION OF SELECTED HYDROCOLLOIDS ON THE TEXTURAL PARAMETRES AND SENSORY QUALITY OF CHICKEN MEAT HAM

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Abstract. The work presents an analysis of the effect of a combined addition of 0.5% carrageenan and selected polysaccharide hydrocolloids (0.05 or 0.1% locust bean gum or mixture of guar and xanthan gums) or 0.7% soy protein isolate on the texture and sensory quality of chicken meat ham. Cooking loss, textural characteristics and sensory indicators were determined in final product after 24 hours of storage. After 3-weeks storage in a chilling room (+4°C) drip loss (drip found inside of vacuum package) and textural characteristics of hams were measured. The results showed that an addition of 0.5% carrageenan in combination with 0.7% soy protein isolate significantly reduced cooking loss and drip loss in chicken meat ham. Texture measurements indicated that use of both additives mentioned affected the texture of the final product: hardness, chewiness and cohesiveness increased significantly. Basing on a sensory evaluation the most desired texture was obtained for hams containing a combined addition of carrageenan (0.5%) and mixture of guar and xanthan gums (0.05%) or locust bean gum (0.1%).

Key words: chicken meat ham, hydrocolloids, texture, sensory quality

INTRODUCTION

Changes in nutrition and new requirements placed by consumers before foods, as well as the necessity of improving the quality, standard and/or prolonging the shelf life of such products, resulted in an increased interest in the use of various additives in the production processes [Gielecińska and Szponar 2001].

Hydrocolloids of plant and animal origin, due to their excellent functional properties, are already in almost common use [Duda 2003]. Among the plant hydrocolloids of special importance are soy protein isolates [Dąbrowski et al. 1992], while among polysaccharide hydrocolloids the most popular are carrageenan preparations [Maciołek 1966, Świderski and Waszkiewicz-Robak 2001].

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The use of carrageenan preparations, which show a water binding ability and retain it within the gel structure obtained, helps limit the drip loss occurring during thermal processing of meat and thus increases the production efficiency and leads to changes in its texture and consistency evaluated by sensory methods [Niederauer 1998, Cierach and Szaciło 2003, Weber 2004]. The water drip occurring during thermal processing (containing mineral salts and proteins) and storage of processed meats is undesirable and may result in the consumer rejecting the product. In the case of products manufactured with the use of carrageenan and vacuum packed the drip observed within the package is to a considerable degree a result of syneresis to which carrageenan gels are subjected [Słowiński et al. 2003]. This phenomenon may be successfully prevented by introducing other hydrocolloids, with condensing properties, demonstrating synergic activity with carrageenan – guar gum, xanthan and locust bean gum [Hydrokoloidy... 1998].

Both the locust bean and guar gum, although they do not gel themselves, improve the gelling properties of kappa carrageenan. Under the influence of the locust bean gum the structure of carrageenan gel changes and becomes similar to gelatine gel. Simultaneously, its syneresis is considerably limited. In turn, the reaction between the guar gum and xanthan results in an increased viscosity of the solution [Rutkowski et al. 2003]. Moreover, xanthan shows an ability to retain molecules of other substances in a suspension, preventing their sedimentation and for this reason is used to stabilize curing brines containing carrageenan [Hydrokoloidy... 1998].

The present work aimed at determining the effect of a combined addition of 0.5% carrageenan and selected polysaccharide hydrocolloids (0.05 or 0.1% of locust bean gum or a mixture of guar and xanthan gum) or 0.7% of a soy protein isolate on the textural properties, measured by instruments and the sensory quality of chicken meat ham evaluated after 24 hours or three weeks of storing in a chilling room at a temperature of +4°C (±2).

MATERIAL AND METHODS

The experimental material consisted of the meat from chicken legs (without skin and bones), purchased before each individual series of analyses. The meat was ground in a laboratory grinder, using a kidney shaped grinder plate and partly also using a plate with openings 5 mm in diameter.

In each of the six experimental series produced were restructured chicken hams of the following, constant composition: 90% – meat ground with the use of a kidney shaped grinder plate, 10% – meat ground using the plate with openings 5 mm in diameter and 80% of brine addition (in relation to meat weight).

The curing brines were prepared directly before curing. In all brine formulas the following components were always used in the same quantities:

– curing salt (0.5% $NaNO_2$ and 99.5% NaCl), 2%,
– sodium isoascorbinate, 0.05%,
– a phosphate mixture Brifisol 512, 0.3%,
– Taroma Ham seasoning mixture, 0.3%,
– kappa carrageenan, 0.5%.

The chicken hams differed in type and quantity of the second polysaccharide hydrocolloid additive or protein (soy protein isolate) added to the meat together with the brine. A description of the ham types is presented in Table 1.

Table 1. Formulas for the chicken meat hams tested
Tabela 1. Opis wariantów szynek z mięsa kurcząt

Formula Wariant	Hydrocolloid added Dodany hydrokoloid	Addition as share of the final product weight, % Wielkość dodatku w stosunku do masy gotowego wyrobu, %
1	without other hydrocolloid (control) bez dodatkowego hydrokoloidu (kontrolny)	–
2	soy protein isolate Supro 595 izolat białka sojowego Supro 595	0.7
3	locust bean gum mączka chleba świętojańskiego	0.05
4	locust bean gum mączka chleba świętojańskiego	0.1
5	mixture of guar gum and xanthan gum (1:1) mieszanina gumy guar z ksantanem (1:1)	0.05
6	mixture of guar gum and xanthan gum (1:1) mieszanina gumy guar z ksantanem (1:1)	0.1

The production of cured meat was performed according to the following recipe: after grinding the meat was mixed with brine in a laboratory mixer (Kenwood) until the brine was totally absorbed (15 min). Individual variants of batter were placed into plastic bags, which were then sealed. The batters were tumbled in a laboratory tumbler MP-74 (PekMont) for 4.5 hours (30 min work and 20 min rest; 6 rev./min). The batters were stuffed into barrier casings 80 mm in diameter using a manual stuffing machine F. Dick. The casings were clipped using a manual clipping tool and placed in metal forms with a compressing press. The scalding was performed in a water bath (Bemar) at a temperature of 80 ±2°C until reaching within the geometrical centre of the casing a temperature of 72°C (within the centre of the ham casing the temperature was measured using a termopar). The scalded ham chubs were cooled in ice water for 30 min and then placed in a chilling room at a temperature of 4 ±2°C for 24 h.

After 24 hours of storage in a chilling room the final product was analysed for cooking loss (according the weight method after separating the gel collected under the casing). Moreover, an instrument measurement of texture was performed and an evaluation of the sensory quality was carried out.

Half of a ham chub from each formula was vacuum packed in a multilayer foil and next stored in a chilling room (temp. 4°C ±2) for three weeks. After that period the drip loss after storage was evaluated (by the weight method after removing the drip present within the packing) and the textural parameters of hams were measured.

The textural parameters were measured on ham samples (cylinders 30 mm high and 40 mm in diameter) using a Zwicki 1120 machine (Zwick) with two parallel plates. The speed of the machine head movement reached 50 mm/min. The samples were compressed twice. The hardness was defined as the maximum force used during the first compression to 50% of its original height; springiness as the ratio between the maximum sample deformation during the first and second compression; cohesiveness as a ration between the work performed during the first and second compression and chewiness as a product of hardness, springiness and chewiness. The penetration force was measured using a cylindrical, flat ended pivot, 13 mm in diameter, on ham slices 30 mm thick. The force value was read when the pivot penetrated 10 mm from the moment the initial stress reached 2N. Each textural measurement was repeated three times and the mean was accepted as the final result.

The sensory evaluation of hams, including such characteristics as colour, aroma, taste and texture were performed by a panel of six researchers and students of the Department of Meat Technology, Warsaw Agricultural University, on the basis of a five point score [Baryłko-Pikielna 1975].

The results obtained were subjected to a statistical analysis based on a one factor analysis of variance. A detailed test of the results was based on Tukey's test, $\alpha = 0.05$

RESULTS AND DISCUSSION

The mean **cooking loss** in hams occurring as result of thermal processing were small (Table 2). However, the statistical analysis demonstrated that this indicator was significantly effected by both type and quantity of functional additives. The greatest weight losses after thermal processing were observed in the control ham, i.e. produced with an addition of only 0.5% of carrageenan, and in the product containing beside carrageenan also 0.05% of locust bean gum (formula 1 and 3). A significantly lower cooking loss – compared to those mentioned – was recorded for ham produced with an addition of carrageenan and 0.1% of a mixture of guar and xanthan gum or 0.7% of soy protein isolate (formula 6 and 3).

Table 2. Effect of selected hydrocolloids on the cooking loss and drip loss in chicken meat hams after 3-weeks storage in a chilling room
Tabela 2. Wpływ wybranych hydrokoloidów na straty masy szynek z mięsa kurcząt powstałe po obróbce termicznej oraz po 3-tygodniowym przechowywaniu w warunkach chłodniczych

Parameter – Cecha		Formula – Wariant					
		1	2	3	4	5	6
Cooking loss, % Straty masy po obróbce termicznej, %	x	0.7^{bA}	0.3^{aA}	0.6^{bA}	0.4^{abA}	0.4^{abA}	0.2^{aA}
	± s	0.43	0.11	0.40	0.21	0.20	0.09
Drip loss after storage, % Starty masy po przechowywaniu, %	x	4.4^{bB}	3.6^{aB}	3.9^{abB}	3.9^{abB}	4.0^{abB}	3.9^{abB}
	± s	0.95	0.36	0.39	0.44	0.68	0.64

x – mean value, ± s – standard deviation.
Means within rows bearing different superscripts (small letters) differ significantly at $\alpha = 0.05$.
Means within columns bearing different superscripts (capital letters) differ significantly at $\alpha = 0.05$.
x – wartość średnia, ± s – odchylenie standardowe.
Wartości średnie oznaczone w wierszach różnymi małymi literami różnią się istotnie przy $\alpha = 0,05$.
Wartości średnie oznaczone w kolumnach różnymi dużymi literami różnią się istotnie przy $\alpha = 0,05$.

Also other authors confirmed that hydrocolloids rendered it possible to effectively limit losses in the ready product caused by thermal processing, simultaneously increasing the production efficiency [Pietrasik and Duda 1999, Wajdzik 2004, Słowiński et al. 2003].

The mean weight loss in ham weight, determined after three weeks of shelf life, measured by the quantity of drip within the casing, were considerably higher than thermal drip and that irrespectively of the type of hydrocolloid used (Table 2). The **drip loss** observed during storage was to a considerable degree the effect of syneresis to which carrageenan gels are subjected. The greatest weight losses were observed in the control ham, while the use of another polysaccharide hydrocolloid or soy protein isolate limited this drip. A detailed analysis of the results obtained demonstrated that the combined addition of carrageenan and soy protein isolate (formula 2) significantly limited storage losses as compared to the control.

A decrease of drip during vacuum storage of pork and chicken sausages as result of a combined addition of kappa carrageenan and soy protein isolate, was also confirmed by the results reported by Adamczak et al. [2000, 2001, 2003 a]. Other investigations conducted by Adamczak et al. [2003 b] demonstrated that the susceptibility of low fat fine ground sausages to syneresis may be successfully limited by a combined addition of 0.25% kappa carrageenan and at least 0.2% xanthan or guar gum.

An addition of a mixture of hydrocolloids differentiated also the **texture** of ham from chicken meat (Table 3). A detailed statistical analysis showed that the hardness of a product obtained with an addition of carrageenan and soy protein isolate (formula 2) was significantly higher than the hardness of hams containing beside carrageenan 0.1% locust bean gum (formula 4) or a mixture of guar gum and xanthan, irrespectively of the quantity used (formula 5 and 6).

After three weeks of storage the hardness of hams increased, irrespectively of the formula used (Table 3). Although the differences observed were not significant statistically, once more the greatest hardness was observed for the product containing soy protein isolate (formula 2), while the lowest for the product containing 0.1% locust bean gum (formula 4). Prolonging the storage from 24 hours to three weeks did not result in significant changes in the hardness of hams from all the formulas. The slight increase in the hardness of the final product could result from the drip from hams occurring during storage.

Changes in the textural properties of meat products (expressed by hardness), caused by adding hydrocolloids separately (carrageenan) or in combinations, was observed also by other authors [Pietrasik 1998 a, Adamczak et al. 2003 a, b, Słowiński et al. 2003].

The mean springiness of hams was similar, irrespectively of whether the storage time was 24 hours or 3 weeks (Table 3). The value of this textural parameter was also not differentiated either by the type or quantity of hydrocolloids used. On the basis of Tukey's test it was ascertained that the springiness of the ready product containing 0.05% of locust bean gum (formula 3), measured after 24 hours of storage, was significantly higher than the springiness of ham containing 0.1% of a mixture of guar gum and xanthan (formula 6).

The mean value for cohesiveness of chicken hams, similarly as springiness, was only slightly affected by the hydrocolloid used (Table 3). A somewhat higher value for this textural parameter, irrespectively of the storage time, was observed for the control ham and for the ham containing soy protein isolate or 0.05% of a mixture of guar gum and xanthan (formula 1, 2 and 5), while the lowest for the product containing 0.1% locust bean gum (formula 4).

Table 3. The effect of chosen hydrocolloids on the textural parameters of chicken meat hams measured in the final product after 24 h and 3-weeks storage in a chilling room
Tabela 3. Wpływ wybranych hydrokoloidów na parametry tekstury szynek z mięsa kurcząt mierzone po 24 h oraz 3 tygodniach przechowywania gotowego wyrobu w warunkach chłodniczych

Parameters – Cecha			Formula – Wariant					
			1	2	3	4	5	6
Hardness, N Twardość, N	24 h	x	64.35^{abA}	69.13^{aA}	65.25^{abA}	61.09^{bA}	63.84^{bA}	63.46^{bA}
		± s	2.77	4.31	7.00	3.66	3.42	3.28
Hardness, N Twardość, N	3 tyg. weeks	x	65.66^{aA}	72.76^{aA}	69.17^{aA}	65.25^{aA}	65.62^{aA}	68.39^{aA}
		± s	6.37	6.23	5.92	7.68	7.47	7.21
Springiness Sprężystość	24 h	x	0.94^{abA}	0.94^{abA}	0.95^{bA}	0.94^{abA}	0.94^{abA}	0.93^{aA}
		± s	0.01	0.01	0.01	0.01	0.01	0.01
Springiness Sprężystość	3 tyg. weeks	x	0.95^{aA}	0.94^{aA}	0.95^{aA}	0.94^{aA}	0.95^{aA}	0.94^{aA}
		± s	0.01	0.01	0.01	0.01	0.01	0.01
Cohesiveness Spoistość	24 h	x	0.63^{abA}	0.63^{bA}	0.62^{abA}	0.61^{aA}	0.63^{abA}	0.62^{abA}
		± s	0.01	0.02	0.02	0.02	0.01	0.02
Cohesiveness Spoistość	3 tyg. weeks	x	0.66^{bB}	0.66^{abB}	0.65^{abB}	0.64^{aB}	0.66^{bB}	0.64^{aA}
		± s	0.01	0.02	0.02	0.01	0.02	0.01
Chewiness, N Żuwalność, N	24 h	x	37.94^{abA}	41.01^{bA}	38.37^{abA}	34.98^{aA}	37.74^{abA}	36.90^{aA}
		± s	2.03	3.51	5.38	2.90	2.12	2.60
Chewiness, N Żuwalność, N	3 tyg. weeks	x	41.37^{abB}	44.98^{bA}	42.45^{abA}	39.17^{aA}	40.85^{abA}	40.95^{abA}
		± s	2.21	2.98	3.86	4.76	3.53	4.30
Penetration force, N Siła penetracji, N	24 h	x	12.74^{aA}	13.66^{aA}	11.81^{aA}	11.82^{aA}	12.04^{aA}	11.07^{aA}
		± s	1.39	2.93	2.72	2.67	2.55	1.53
Penetration force, N Siła penetracji, N	3 tyg. weeks	x	13.34^{bA}	13.58^{bA}	12.27^{abA}	12.55^{abA}	12.36^{abA}	11.55^{aA}
		± s	1.22	1.86	1.58	1.58	1.06	1.43

x – mean value, ± s – standard deviation.
Means within rows bearing different superscripts (small letters) differ significantly at $\alpha = 0.05$.
Means within columns bearing different superscripts (capital letters) differ significantly at $\alpha = 0.05$.
x – wartość średnia, ± s – odchylenie standardowe.
Wartości średnie oznaczone w wierszach różnymi małymi literami różnią się istotnie przy $\alpha = 0{,}05$.
Wartości średnie oznaczone w kolumnach różnymi dużymi literami różnią się istotnie przy $\alpha = 0{,}05$.

The storage of the ready product for three weeks in a chilling room had a significant effect on cohesiveness – on the average it increased by 0.03 units, irrespectively of the experimental formula. Somewhat smaller, statistically not significant changes in cohesiveness, were observed for ham with an addition of 0.1% of a mixture of guar gum and xanthan (formula 6).

In other studies an univocal effect of the addition of hydrocolloids on cohesiveness was also not observed. Adamczak et al. [2003 b] reported that the differences in the cohesiveness of cooked fine ground sausages containing hydrocolloids were observed only after 2 weeks of storage in a chilling room. Moreover, the use of carrageenan together with xanthan resulted in an increased cohesiveness of the ready product when compared with sausages produced with the use of guar gum. In turn, Pietrasik [1998 a] stated that it was the share of fat and not the addition of carrageenan or gellan gum that determined the cohesiveness of fine ground cooked sausages.

Irrespectively of the length of storage of the final product in a chilling room, the chicken hams containing soy protein isolate (formula 2) were characterized by the greatest chewiness (Table 3). A lower chewiness than for formula 2 was observed for hams containing 0.1% locust bean gum (formula 4) and after 24 hours of storage also the ham with a share of 0.1% of a mixture of guar gum and xanthan (formula 6). Despite the increased chewiness observed for all ham formulas with the increasing storage time statistically significant differences were observed only for the control ham.

An increased chewiness of processed meats, as result of the use of hydrocolloids, was observed also in other studies. According to Pietrasik [1998 a], already an increase of the addition of carrageenan to the batter resulted in an increased chewiness of fine ground sausages. In turn, Adamczak et al. [2001] observed that an increased chewiness of sausages containing carrageenan and soy protein isolate and/or wheat fibre was retained throughout a 2 weeks storage period.

The highest mean penetration force, both after 24 hours and 3 weeks of storage, was observed for the chicken ham produced with an addition of soy protein isolate, while the lowest for the product containing 0.1% of a mixture of guar and xanthan gum (Table 3). The combined use of locust bean gum or guar gum and xanthan lead to a slight “slackening” of the ham structure when compared to the control formula, expressed by a lower penetration force. Prolonging the storage time from 24 hours to 3 weeks resulted in a slight, statistically not significant, increased in penetration force.

Sliced chicken hams were subjected to a **sensory evaluation** 24 hours after manufacturing. The mean scores obtained for individual sensory attributes are presented in Table 4.

Colour and aroma of the ready product were estimated as typical for this product and the meat used and the mean score for those indicators was high (Table 4). The functional additives used had no significant effect on the colour and aroma of chicken meat hams.

It was demonstrated in other studies that the combined use of carrageenan and xanthan or guar gum, contrary to a separate addition of those components, resulted in a higher evaluation of the colour of hotdogs with a lowered fat content [Adamczak et al. 2003 b].

The taste of ham meat was not differentiated by the type and quantity of the polysaccharide hydrocolloids used or by the soy protein isolate. A score slightly higher than the remaining products was obtained for the ham containing 0.1% of a mixture of guar and xanthan gum (formula 6).

Table 4. The effect of chosen hydrocolloids on the sensory quality of chicken meat hams evaluated after 3-weeks storage of the final product in a chilling room
Tabela 4. Wpływ wybranych hydrokoloidów na jakość sensoryczną szynek z mięsa kurcząt ocenianą po 24 h przechowywania gotowego wyrobu w warunkach chłodniczych

Parameters – Cecha		Formula – Wariant					
		1	2	3	4	5	6
Colour – Barwa	x	4.6^{a}	4.5^{a}	4.7^{a}	4.5^{a}	4.5^{a}	4.6^{a}
	± s	0.29	0.21	0.18	0.09	0.16	0.27
Aroma – Zapach	x	4.6^{a}	4.6^{a}	4.7^{a}	4.7^{a}	4.6^{a}	4.7^{a}
	± s	0.10	0.18	0.07	0.04	0.19	0.08
Taste – Smak	x	4.5^{a}	4.5^{a}	4.5^{a}	4.5^{a}	4.5^{a}	4.7^{a}
	± s	0.22	0.20	0.26	0.23	0.08	0.08
Texture – Konsystencja	x	4.3^{a}	4.6^{ab}	4.6^{ab}	4.7^{b}	4.7^{b}	4.6^{ab}
	± s	0.29	0.22	0.19	0.19	0.11	0.17

x – mean value, ± s – standard deviation.
Means within rows bearing different superscripts differ significantly at α = 0.05.
x – wartość średnia, ± s – odchylenie standardowe.
Wartości średnie oznaczone w wierszach różnymi literami różnią się istotnie przy α = 0,05.

The results obtained correspond to those reported by other authors, who confirmed that an addition of the chosen hydrocolloids had no negative effect on the taste of meat products, evaluated by sensory methods. Due to the specific effect on the taste of meat products the use of polysaccharide hydrocolloids may result in intensification of positive impressions as regards the taste of low-fat and chicken cured meats [Pietrasik 1998 b, Adamczak et al. 2003 b, Słowiński et al. 2003].

According to the panelists, the least desirable texture was observed for the control product, i.e. containing only carrageenan (formula 1). The introduction of soy protein isolate or another polysaccharide hydrocolloid, beside carrageenan, improved the texture of chicken hams. A significantly better texture in comparison with that of the control product was observed for chicken hams containing 0.1% locust bean gum or 0.05% of a mixture of guar and xanthan gum (formula 4 and 5).

The positive effect of an addition of carrageenan or a combined addition of two different hydrocolloids on the texture of meat products, including those with a lowered fat content, evaluated by sensory methods, has also been confirmed by the results of other studies [Pietrasik 1998 b, Lachowicz et al. 1999, Adamczak et al. 2003 b, Słowiński et al. 2003, Wajdzik 2004].

CONCLUSIONS

1. An addition of 0.5% of carrageenan together with soy protein isolate or 0.1% of a mixture of guar and xanthan gum to chicken meat ham significantly limited the cooking loss in final product. After three weeks of storage in a chilling room the product containing soy protein isolate demonstrated a significantly lower weight loss than the control ham, containing only 0.5% of carrageenan.

2. The textural parameters of the final product, evaluated by instrumental methods, were affected to the highest degree by an addition of carrageenan together with 0.7% of soy protein isolate, causing a significant increase in hardness, chewiness and springiness of the final product after 24 hours of storage and of chewiness and penetration force after 3 weeks of storage in a chilling room.

3. A sensory evaluation did not show any significant effect of the hydrocolloids used on the colour, aroma or taste of chicken meat ham. The most desirable texture was recorded for hams containing 0.5% of carrageenan and 0.05% of a mixture of guar and xanthan gum or 0.1% locust bean gum.

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WPŁYW WYBRANYCH HYDROKOLOIDÓW NA TEKSTURĘ ORAZ WYRÓŻNIKI JAKOŚCI SENSORYCZNEJ SZYNKI Z MIĘSA KURCZĄT

Streszczenie. Celem pracy było zbadanie wpływu łącznego dodatku 0,5% karagenu i wybranych hydrokoloidów polisacharydowych (po 0,05 lub 0,1% mączki chleba świętojańskiego lub mieszaniny gumy guar z ksantanem) lub 0,7% izolatu białka sojowego na teksturę i jakość sensoryczną szynki z mięsa kurcząt. W gotowym wyrobie po 24 h od wytworzenia oznaczano straty masy po obróbce cieplnej, przeprowadzano instrumentalny pomiar parametrów tekstury oraz ocenę sensoryczną, natomiast po 3 tygodniach przechowywania chłodniczego (+4°C) oznaczano straty masy (wyciek obecny w opakowaniu próżniowym) i mierzono parametry tekstury. Dodatek 0,5% karagenu łącznie z 0,7% izolatu białka sojowego istotnie ograniczał straty masy po obróbce termicznej i 3-tygodniowym przechowywaniu szynki z mięsa kurcząt oraz wzmacniał teksturę gotowego wyrobu, czego objawem był wzrost twardości, żuwalności i spoistości. Najbardziej pożądaną konsystencją ocenianą sensorycznie charakteryzowały się szynki z łącznym dodatkiem 0,5% karagenu i 0,05% gumy guar z ksantanem lub 0,1% mączki chleba świętojańskiego.

Słowa kluczowe: szynka z mięsa kurcząt, hydrokoloidy, tekstura, jakość sensoryczna

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