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Effect of Curing Procedure on Water Holding Capacity and Heat Penetration into Cured Hams.

Heat penetration into cured meat is dependent on a large number of factors, the most significant among them being fresh meat quality-muscle marbling, duration of meat processing, quality of meat ready to be heat treated (thickness of subcutaneous fatty tissue, direction of muscle fibers in relation to heating medium), initial temperature of meat product and its uniformity, heat treatment procedure. Most of the above mentioned factors have already been examined and there are data on that subject in the literature (2, 3, 4, 5, 10, 14, 15).

In our previous experiments, examining the factors which can play a certain role in the pasteurization of canned hams we have noticed that the heat penetration into geometrical center of these products is influenced both by duration of meat processing and water holding capacity. Having this in mind, we decided to examine whether and to which extent, hydration, depending on curing procedure, influences the heat penetration into cured pork.

Experimental

After usual sides chilling to + 4^{o} in the butt center (about 20 hours) and after dressing, test hams were divided into two groups: left ham group and the right one.

Curing was carried out both by brine pumping into a. iliaca externa and by immersion in a cover pickle. In the work the following two procedures were applied:

Curing Procedure I (left ham group).
Test hams of this groups were pumped by 15 percent with nitrate-nitrite brine, calculated on the weight of trimmed bone-in hams. Concentration of common salt in the pickle was 15 percent. Besides the above mentioned ingredients, the pickle contained the polyphoshate preparation (2,8 %) and sugar, too.

Ham immersion for 48 hours was carried out in nitrate-nitrite cover pickle being of the same common salt concentration but without polyphosphate preparation and sugar.

Hams were drained for 48 hours.

Curing Procedure II (right ham group).
Test hams of this group were pumped by 8 percent with nitrate-nitrite brine, calculated in the same way as in the first procedure. Concentration of common salt in the pickle was 25,4 percent. This pickel also contained the polyphosphate preparation (5 %) and sugar.
96 hour ham immersion was performed in a nitrate-nitrite cover pickle being of the same common salt concentration as the pumping brine but without polyphosphates and sugar.

Hams were drained for 192 hours.

Cured hams containe' practically the same quantities of curing ingredients regardless of curing procedure.

Temperature of the curing and draining department as well as the pickle one ranged from + 4 to + 5 ^{o}C in both procedures.

Further processing of hams - complete trimming of intermuscular fatty and connective tissues - was the same in both ham groups.

Immediately after filling and closing hams into cans, thermocouple setting and exhausting, hams were pasteurized at 78°C (± 0,5).

Water holding capacity (WHC) of cured meat was determined by Grau´s compression method modified by Sonja Karan-Djurdjič. A slice, 12 x 8 x 1 - 1,2 mm in size, was cut from cured ham prior to filling it into can and weighed on a filter paper of a known weight by analytical balance. The weighed sample was covered with another filter paper of a known weight. Meat slice covered with papers was pressed between two glass plates. The upper plate was loaded with a 200 g weight. After 15 minute pressing, filter papers free of meat slice were immediately weighed. The percentage of pressed-out juice was calculated 85 the relation of the weight of absorbed juice by both filter papers to the weight of the examined cured meat sample.

These tests were carried out with two muscles - m.aductor (A) and m.gluteus profundus (B) - of each ham, prior to filling it into can. Slices were taken from muscle surfaces at os femoris side.

Heat penetration rate was determined by temperature-time checkings in the geometrical center of hams in "oblong" cans 103,2 x 140,6 x 297 mm in size.

Temperature was registered in 5 minute intervals till 64°C were reached in the canned ham center. From that moment on, temperature was registered each minute in order to establish the number of minutes of heating until canned ham center reached 65°C. Further temperature changes were not of interest from the standpoint of tne work.

The rate of heat penetration was expressed as:

- heating time in minutes to reach 65°C in geometrical center (t); and
- number of minutes (f) required to reduce the quotient of $T_1 - T_c$ and $T_1 - T_o$ differences to a tenth.

$$f = \frac{T_1 - T_c}{T_1 - T_o}$$

T_1 = processing temperature
T_2 = ham temperature in the geometrical center
T_o = initial ham temperature in the geometrical center.

On occasion of interpreting the results, hams were divided into three groups according to quantity of pressed-out juices i.e. to their water holding capacity. The group of hams having moderate hydration consisted of hams which values of pressed out-juices expressed in percent were in ranges 15,79 ± 7,18 (15,79 being the mean value for determined pressed-out juice percentage of all examined hams ± 7,18 standard deviation).

Hams having percentages of pressed out-juices higher than the mentioned range were considered as a group of low hydrated hams and hams having pressed out - juice values lower than 8,61 were in the group of hams with high water holding capacity.

Results and Discussion

Effect of curing procedure on water holding capacity and on heat penetration into geometrical center of "oblong" hams during pasteurization (78°C)

Table 1 *

Curing procedure	Percentage of pressed out juices for cured muscles			t (min.)	f (min.)	Number of samples (N)
	A	B	(A+B):2			
I	11,96	10,13	11,06	222,72	266,0	11
II	20,94	20,10	20,52	213,36	254,47	11

From the data presented in Table 1, the following may be seen:

- curing procedure is of essential importance for water holding capacity of hams. Pressed out-juice percentage of hams cured by the procedure I (15 percent of pumped brine; process time - 96 hours) was lower for 9,46 compared to pressed out-juice percentage of hams cured by the procedure II (8 percent of pumped brine; process time - 288 hours);
- canned hams cured by the procedure I require additional 9,36 minutes to reach 65°C in the geometrical center compared to hams cured by the procedure II;
- time in minutes (f) necessary to reduce the quotient of $T_1 - T_c$ and $T_1 - T_o$, for lo times amounts to 266,0 minutes in hams cured by the procedure I and to 254,47 minutes, namely 11,53 minutes less, in hams cured by the procedure II.

Effect of curing procedure and hydration on heat penetration into geometrical center of "Oblong" hams during pasteurization (78°C).

* The above mentioned values represent mean values of all examined test hams, separately for each curing procedure.

Table 2 *

Curing procedure	Hydration of cured ham muscles	Pressed out-juice percentage for cured muscles (A + B) : 2	(min.)	(min.)	Number of examined hams (N)
I	high	6,85	227,50	265,50	2
	moderate	12,00	221,67	266,11	9
II	moderate	15,58	215,00	257,43	7
	low	29,18	210,50	256,00	4

On the base of the data presented in Table 2, the following may be seen:

- high hydrated hams cured by procedure I needed 5,83 minutes more to reach 65°C than the hams having moderate hydration treated by the same curing procedure. Consequently, heat penetration rate for hams having high hydration (pressed out-juice percentage = 6,85) is lower in relation to hams having moderate hydration (pressed out-juice percentage = 12,0).
- canned hams having moderate hydration cured by procedure II require on average 4.5. minutes more to reach 65°C in the geometrical.center in relation to hams having low hydration and cured by the same procedure. Heat penetration into hams having lower pressed out-juice percentages (15,58) is somewhat retarded in relation to hams having higher pressed out-juice values (29.18).
- canned hams having moderate hydration show different heat penetration rates depending on the applied curing procedure, namely hams cured by the procedure I require 6,67 minutes more to reach 65°C in the geometrical center;

* The above mentioned values represent mean values of all examined test hams, separately for each group of test hams (according to hydration) and for each curing procedure.

- comparing the "f" values of hams having higher and lower hydration within the same curing procedure, small differences were established which can be understood if definition of this value is taken into consideration.

x

x x

The results presented in Table 1 show that heat penetration into geometrical center of "oblong" hams is more rapid on occasion of application of longer curing procedure and a lower quantity of pumped brine in relation to heat penetration into hams cured by shorter procedure and a higher quantity of pumped brine (I).

Besides curing procedure, the water holding capacity also influences the heat penetration into cured meat (Table 2). However, influence of this factor is dependent on the applied curing procedure. For canned hams cured by procedure I shorter one, and with higher quantity of pumped brine, the required number of minutes for ham geometrical center to reach a certain temperature increases simultaneously with the water holding capacity namely heat penetrates more slowly.

Influence of hydration rate on heat penetration was also registered among hams cured by the second curing procedure.

The observed differences in heat penetration rate for canned hams due to water holding capacity are of relative significance. Ham hydration cannot be considered separately but always with the complex, in this case termed by common name "curing procedure". So the dependance of heat penetration into hams to ham hydration was established by observing two groups of hams having different curing procedures (it was shown that hams cured by the procedure I have higher hydration and lower heat penetration than hams cured by the procedure II).

Biochemical changes in the course of curing result in the release of a certain quantity of juice during heat treatment. If curing procedure is longer, the above mentioned appearances are more intensive. By circulation of larger quantities of cooked-out juices, heat transfer is faster and consequently hams are heated more rapidly (curing procedure II). Opposite to that, hams cured by the shorter procedure, namely hams having higher hydration release less juice during pasteurization and owing to that those hams are heated more slowly.

It is a fact that meat hydration rate, separately considered, is not a dominant factor on occasion of heat penetration. The observed differences in heat penetration into cured hams should be considered from the aspect of biochemical changes taking place during curing procedure and heat treatment.

Conclusion

On the base of the obtained results, the following conclusions may be drawn out:

1. During pasteurization by applying the shorter curing procedure with higher quantity of pumped brine having lower common salt concentration, heat penetrates into geometrical center of "oblong" hams more slowly in relation to hams cured by the longer procedure with smaller quantity of pumped brine having higher common salt concentration;
2. The ham hydration influences the heat penetration rate. Influence of this factor is less important than curing procedure.

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