HEATING RATE OF CURED CANNED HAMS DURING PASTEURIZATION

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SUMMARY

Pork leg muscles were injected with various amounts of curing brine. Composition of brines was thus formulated to obtain identical percentages of main curing ingredients in the finished product. In some experiments hams contained 2 p.c. of soya preparation. Cured hams, stuffed into 14 lbs oblong cans were cooked at 81.3°C. Recorded temperatures of the geometrical centre of hams were used for fl and f_2 calculations, i.e. temperature response parameters. The results show that the increasing amounts of injected curing brine cause faster heating of canned hams. Higher amounts of added water having accelerated heat penetration have decreased both f_1 and f_2 values. Higher heating rates result in shorter times required to reach 70.°C in the coldest point of canned hams.

INTRODUCTION

One of the parameters necessary for heat processing calculations is the f value. The f value represents the time required for a tenfold reduction of the difference between heating medium temperature and the temperature at a given point of a canned product. On a time-temperature curve plotted on semilogarithmic paper, greater portion of the curve is asymptotic to a straight line. Time required for the asymptote to traverse one logarithmic cyclus is designated as f value. Therefore the f value is a very useful indicator of the heating rate (heat penetration rate), provided that the heating medium temperature and thermal diffusivity of the heated product are both constant.

For an adequate estimation of the f value, choice of a suitable temperature scale for plotting time-temperature curves is arbitrary.

The f value i.e. the heating rate is influenced by many factors. One of the crucial factors for heat penetration rate are the characteristics of the heated substrate. Considering meat as a substrate to be heated, water holding capacity (WHC) does influence the f value (Šuvakov et al. 1978). pH value of a meat substrate (Panin et al. 1979), NaCl addition, PSE (pale, soft, exudative) and DFD (dark, firm dry) characteristics of meat, also influence the heating rate (Radetic et al. 1980). The amount of added water to meat butters accelerates the heating rate (Šuvakov et al.1984; Šuvakov et al.1986).

The purpose of the experiments was to establish how the amount of injected curing brine would influence the heating rate of canned hams during pasteurization. The same amount of curing ingredients was incorporated to all experimental hams. However, higher content of water in hams was obtained on account of the meat content by injecting higher amounts of more diluted curing brines. Experimental hams in the experiments 2 and 3 contained 2 p.c. soya preparation (Supro 500-E, having 90 p.c. N x 6.25).

MATERIALS AND METHODS

Raw materials.

Pork leg muscles (without shank), trimmed off from fatty and connective tissues were used in the experiments. In order to separate out meat with PSE or DFD characteristics, pH value determination was carried out 45 minutes and 24 hours post mortem. Whole muscles, i.e. muscle groups were used in the experiments 1 and 2. A part of injected meat (3 p.c.) was minced through 3 millimetre holes (2/16 inch). In experiment 3 injected meat was chopped through 12 millimetre diameter holes (8/16 inch) mincer. Curing brine was injected by multi-needle pickle-injector.

Composition of curing brines in shown in table 1, and the injected amounts in table 2.

Massaging of injected meat was carried out in separate massaging-vats for each experiment. Massaging has lasted 18 hours, 12 minutes massaging periods were followed by 18 minutes of pause.

Cured meat was stuffed into 14 lbs oblong cans sized 167 x 104 x 354 millimetres (0609 x 0402 x 1315 inch). All experimental hams were pasteurized in the same cooking-vat at 81.3°C (178.3°F) until 70.3°C (158.5°F) was reached in the coldest point of experimental ham with the lowest heating rate. At this moment pasteurization was discontinued by letting the warm water to drain out. Cooling was accomplished by the running tap water (21.3°C; 70.3°F).

Determination of the heating rate.

Heating rate was determined according to Ball and Olson (1957) procedures modified by Šuvakov et al. (1986). Estimated f_1 and f_2 values were used to compare the

Table 1 - Ingredients used for preparing curing brines (kilograms)

	Experiments 1	2	3
tap water	70.435	82.108	84.594
common salt	21.666	8.388	7.222
dextrose	4.166	1.613	1.389
polyphosphate (Tari P22)	3.600	1.387	1.194
sodium nitrite	0.133	0.052	0.044
soya preparation (Supre 500-E)	0.000	6.452	5.555

Table 2 - Raw material compostiion of experimental hams (kilograms)

	Experiments 1	2	3
Meat			
Whole muscles	85.000	66.000	0.000
chopped muscles	3.000	3.000	64.000
total meat:	88.000	69.000	64.000
Injected brine			
water	8.452	25.452	30.452
common salt	2.600	2.600	2.600
dextrose	0.500	0.500	0.500
polyphosphate	0.432	0.432	0.432
sodium nitrite	0.016	0.016	0.016
soya preparation	0.000	2.000	2.000
total brine	12.000	31.000	36.000

Table 3 - Heating rates of experimental hams during pasteurization f values (minutes)

Indicators of heating rate		Experiments 1	2	3
f_1		106	100	97
	from ... to min	21-71	21-66	21-81
f_2		300	266	260
	from ... to min	71-276	66-296	81-291
f_c		276	265	260
	from ... to min	311-466	311-466	301-466
time necessary to reach 70.3°C after cut, gdt		276	243	261
time necessary to reach 40°c		175	165	168

cut = coming-up time
gdt = go-down time

heating rates among experimental hams. Similar procedures were used for the cooling rate determination. Cooling rate was represented as f_c value.

Experimental hams produced in experiment 1, can be classified as regular shankless export hams, those produced in the experiment 2 as "soya and water added (20 p.c.)". In experiment 3 a "chopped ham, soya and water added (30 p.c.)" product was produced. None of the products had more than one percent of cooked-out juice.

RESULTS AND DISCUSSION

The results in table 3 show that hams injected with 12 p.c. of curing brine (experiment 1) have the lowest heating rate, both in the initial phase of heating (f_1 = 106 min) and in the remainder period of heating (f_2 = 300 min). Those hams injected with 31 p.c. curing brine (experiment 2) have had higher heating rates compared to the hams produced in experiment 1 (f_1 = 100 min; f_2 = 266 min). Chopped ham (experiment 3), containing 36 p.c. of injected curing brine showed the lowest f_1 (97 min) and f_2 (260 min) values, i.e. the highest heating rate.

From the results presented in table 3 it is evident that there are differences among experiments in duration of the phase of fast heating. Therefore hams containing the lowest amount of injected brine have the period of high heating rate which lasted from 21st to 71st minute of pasteurization (calculated after coming-up time). Shorter period of fast temperature rise was estimated for hams in experiment 2 (21st to 66th min), while chopped ham (experiment 3) had the longest period of fast heating (21st to 81st min). However, if we consider the time required to reach 70.3°C(158.6°F) in the coldest point of the product, it is obvious that the mount of injected curing brine does influence that time too, although it should be pointed out that time depends on the initial temperature.

From the results presented the table 3 we can see that finding on heating rate could also be applied to cooling rate of pasteurized hams. Namely, the lowest cooling rate was determined in hams injected with the lowest amount of curing brine. The highest cooling rate was demonstrated in hams (lowest f_c values) injected with 36 p.c. brine.

These findings demonstrate the importance of the amount of injected curing brine for the heating rate of canned hams. Namely, the influence of curing ingredients which may alter the water holding capacity of cured meat (one of the substantial factors decelerating heating rate) was nullified in our experiments because those substances were incorporated to all hams in equal amount. The purpose of soya preparation addition was to eliminate the microconvectional streaming of juices released during pasteurization (caused by coagulation of proteins) which would have contributed to higher heating rates. Discussing the results it should be considered that in experiments 1 and 2 whole muscles were used, whereas in experiment 3 the chopped ones, in that way the effect of direction of heat penetration (parallel or perpendicular to muscle fibres) was eliminated.

CONCLUSIONS

The results allow us to conclude that the amount of the injected curing brine has an essential influence on the heating rate of canned hams during pasteurization.

Highest amount of injected brine resulted in the highest heating rate, and vice versa, the lowest heating rate was recorded on those hams with the lowest amount of injected brine. This statement is valid only if the amounts of main curing ingredients are identical in experimental hams. The previous statement is limited to the amounts of injected brine used in our experiments. Therefore, the amount of the injected curing brine should be taken into account in heat processing calculations.

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