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ZDZISŁAW KOWALSKI
MAREK PANASIK
WŁADYSŁAW BYKOWSKI
ANNA ŻÓŁTOWSKA

THE COMPARISON OF HOT CUT AND CHILLED BEEF AS RAW MATERIAL FOR THE PRODUCTION OF COMMINUTED SAUSAGES

Meat and Fat Industry Research Institute, Warszawa

Key words: *Longissinus dorsi*, WHC, comminuted sausages, *pre-rigor* process, after chilling process

Some physico-chemical properties of hot cut and chilled *longissimus dorsi* muscle removed *pre-rigor* or after chilling process were compared. The hot processed LD muscles of three experimental groups showed higher pH and WHC and much lower free water content than chilled muscles. Their effect upon the yield and some quality characteristics of model comminuted sausages was determined. The differences in consistency and juiceness of model sausages were significant.

INTRODUCTION

The usage of hot processed young bull for the production of cooked sausages has a certain tradition in Poland. Namely, before the second world war the butchers applied hot cut beef to increase the yield and improve the quality of frankfurters. The first experiments on industrial scale had been carried out in Poland by Bykowski in 1952-1955 [27] and then followed the others [9, 12]. In the Meat Industry Institute the experiments with hot processed pork and beef for the production of sausages and canned meat, including hams were carried out in 1971-1973 [5, 23, 27]. The report presented here is a part of unpublished results obtained by Kowalski and co-workers [23]. Some histological and biochemical properties including penetration of curing agents of hot processed and chilled pork were studied at the Agriculture University, Warsaw [4, 25, 26, 28]. A great deal of scientists: Hamm, Wirth, Heinz, Ungethüm, Ray, Sałuskova, Proselkova, Pisula, Mroczek, Wasilewski and others point out the difference between physico-chemical parameters of hot processed meat and chilled meat [1, 4, 7, 10, 13, 14, 20, 22, 25, 26, 28,

30, 31, 32, 34, 35, 36]. The most important from the technological point of view differences concern binding properties, water-holding capacity (WHC) and the speed of penetration of curing agents which is higher in hot processed pork, as Pisula et al. showed [28]. High WHC of *pre-rigor* muscles maintained for about 3 hours can be extended for a longer time when meat is frozen directly after slaughter or better first salted and then frozen [1, 7, 11, 14, 15, 16, 17, 21, 35, 36]. Analysing the published results [5, 8, 9, 17, 18, 19, 21, 23, 24, 27, 30, 32, 34, 35, 36] it can be seen that the usage of hot processed beef (fresh or frozen) for the production of cooked emulsion type sausage is the most efficient from among the other methods of meat processing.

The purpose of this study was to compare the properties of hot cut chilled beef *longissimus dorsi* muscles and to determine their effect upon the yield and some quality characteristics of model comminuted sausage. Moreover the influence of age and sex of animals was observed.

EXPERIMENTAL

The experiments were carried out on *longissimus dorsi* muscles (LD) which were removed from the right fore-quarter directly *post mortem* (1.5 h) and from the left quarter after chilling process (24 h). There were three experimental groups, each of seven animals: heifers, young bulls and cows. All physico-chemical measurements of muscles of heifer-beef (HB), young bull-beef (BB) and cow-beef (CB) and production of model sausage were carried out in slaughterhouse in Warsaw. The determinations of some objective characteristics of model sausage were carried out in the laboratories of our Institute. The obtained results were checked on industrial scale in the production of cooked emulsion type sausages. The production of model comminuted sausage was as follows: the batch of hot processed meat or chilled meat consisted of LD muscles of all experimental groups: HB, BB, and CB. Muscles in pieces were cured 24 h with the following mixture: 2.4% NaCl, 0.02% $NaNO_3$ and 0.03% $NaNO_2$ and then chopped with added water (30%) on a small laboratory cutter. The emulsion was chilled and stuffed into 60 mm collagen casings. The sausages were cooked for 55 minutes in water bath at 70°C, then chilled and weighed before and after storage for 24 h at 2-4°C. The cooking and storage losses were calculated. The productions of cooked sausages on industrial scale were carried out in Meat Packing House in Nisko. Two types of comminuted emulsion type sausages were produced („Parówkowa" and „Mortadela"). Hot processed beef was added to these sausages in the amount of 40% to 65%. The other raw materials were chilled.

The following muscle characteristics were measured:

— temperature with thermometer,

— ph using pH Meter Radiometer 24 e with dagger electrodes,

— colour using portable device patented by Tyszkiewicz et al. [33],

— water-holding capacity at determined intervals using Grau and Hamm's method modified by Pohja and Niinivaara [29],

— free water content ("drip" water) using device patented by Bykowski and Bałaszkiewicz [6].

The model cooked sausages were studied according to the procedure which is applied in our Institute for different meat products [2, 3]:

— cooking loss and storage loss as the difference in weight between raw and cooked sausages and after storage,

— juiceness as the amount of pressed out juice using Laboratory Carver Press (20 g sample was pressed for 5 minutes at the pressure of 220 kg/cm^2). The amount of juice was calculated as a difference in weight before and after test,

— consistency using Richardson's Penetrometer (the depth of penetration of ball-shape plunger into the sample during 5 seconds),

— tenderness using Lee — Kramer Shear Press, 3000 lbs ring (surface under a curve counted per gram of sample).

RESULTS

The obtained results for physico-chemical characteristics of muscles model comminuted sausages are calculated for each experimental group as average values (Table 1 to 4). pH values and brightness of colour of hot cut and chilled LD muscles are shown in Table 1. For all experimental groups the same tendency can be seen; it is much higher pH of hot cut muscles (1.5 h *post mortem*) than chilled muscles (24 h) and lower brightness of colour. The results of water-holding capacity and

Table 1. The average values of pH and brightness of colour of hot cut and chilled *longissimus dorsi* muscles

Experimental groups	pH of LD muscles		Brightness of colour muscles	
	hot cut	chilled	hot cut	chilled
Heifer-beef	7.18	6.11	21.4	25.5
Young bull-beef	7.17	6.36	21.4	22.9
Cow-beef	6.88	6.10	18.9	22.7

hot cut muscles — 1.5 h *post mortem*
chilled muscles — 24 h *post mortem*

Table 2. The average values of water-holding capacity (WHC) and water content of hot cut and chilled LD muscles

Experimental groups	WHC of LD muscles		Free water content of LD muscles	
	hot cut	chilled	hot cut	chilled
Heifer-beef	99.6	78.3	13.3	29.8
Young bull-beef	97.9	81.1	14.4	28.3
Cow-beef	99.0	83.4	13.8	33.1

hot cut muscles — 1.5 h *post mortem*
chilled muscles — 24 h *post mortem*

free water content are presented in Table 2. The differences between hot cut muscles and chilled muscles are great. Mainly it concerns free water content which is two times lower in hot processed muscles. The results indicate that the holding of water is much stronger in hot cut muscles. The changes of WHC in hot cut heifer-beef LD muscles during 4 hours *post mortem* are given in Figure. At the beginning till 3.5 h *post mortem* the decrease of WHC in hot cut muscle is low, later it is faster.

The results obtained for model comminuted sausages are presented in Tables 3 and 4. Cooking and storage losses (Table 3) are much higher in sausages produced of chilled muscles. Quality characteristics of model sausages are presented in Table 4. The analysis of data shows that the difference in consistency is significant ($P < 0.05$) and in juiceness highly significant ($P < 0.001$) but non significant in tenderness. It means that

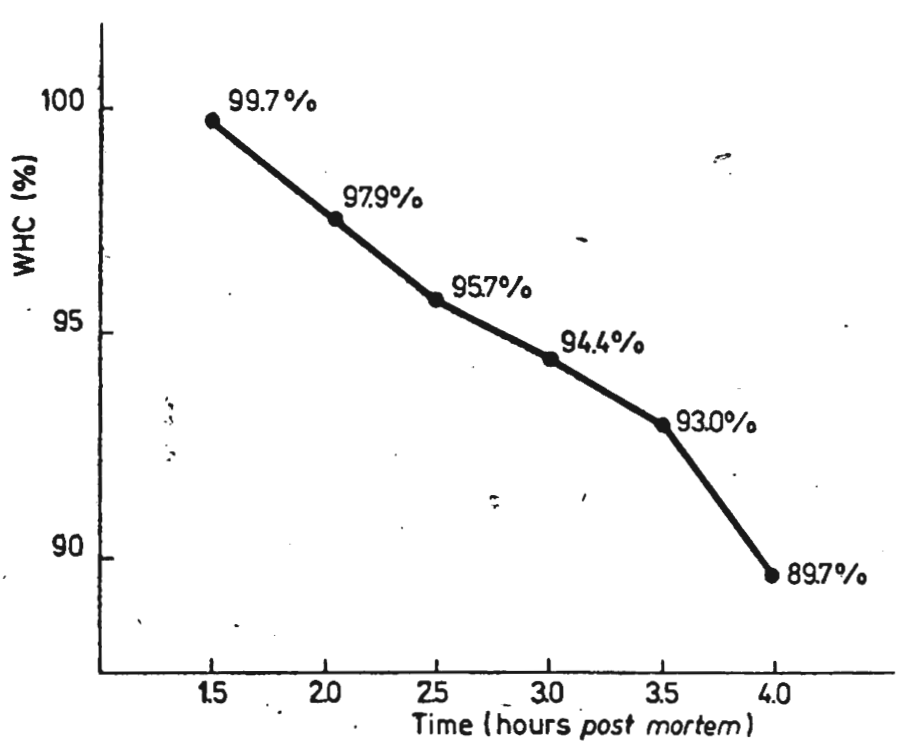

Fig. Water holding capacity of hot cut LD muscle (the measurement each 30 minute from 1.5 h till 4 h *post-mortem*)

Table 3. Cooking and storage losses of model comminuted sausages

The model sausages	The weight losses	
	after cooking	after cooking and storage
Sausage produced of hot cut LD muscles	0.8%	4.1%
Sausage produced of chilled LD muscles	4.5%	8.1%

Table 4. Consistency, juiceness and tenderness of model comminuted sausages

Quality characteristics of model sausages	The model sausages produced of	
	hot cut LD muscles	chilled LD muscles
Consistency (the depth of penetration)	15.3 unit	16.9 unit*
Juiceness (the amount of pressed juice)	11.7%	16.1%***
Tenderness-shear value (the surface under curve(g)	6.4 mm²	6.3 mm²

* — significant difference ($P < 0.05$)
*** — highly significant difference ($P < 0.001$)

model sausage produced of hot cut muscles has more tough consistency and better bound juices than the one produced of chilled muscles.

The results obtained on industrial scale in the production of two kinds of cooked sausages ("Parówkowa", "Mortadela") confirm our laboratory results. The sausage produced with the addition of hot cut beef showed higher yield (4% to 8%) and better colour. Our results are in agreement with other published data.

CONCLUSIONS

On the basis of obtained results the following conclusions can be drawn:

1. Hot cut *longissimus dorsi* muscles have, independently of age and sex of experimental animals, much higher pH value and WHC and much lower free water content than chilled muscles.
2. The advantageous properties of hot cut muscles are kept till 3.5 h

post mortem and during this time hot beef should be utilized in the production of cooked sausages.

3. The usage of hot cut beef decreases the cooking and storage losses of model comminuted sausage and increases the yield of sausages produced on industrial scale.

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Z. Kowalski, M. Panasik, W. Bykowski, A. Żółtowska

PORÓWNANIE MIĘSA WYKRAWANEGO NA CIEPŁO I PO WYCHŁODZENIU W PRODUKCJI KIEŁBAS DROBNOROZDROBNIONYCH

Instytut Przemysłu Mięsnego i Tłuszczowego, Warszawa

Streszczenie

Porównanie właściwości mięsa wykrawanego na ciepło i po wychłodzeniu. Doświadczenie przeprowadzono na mięśniach *longissimus dorsi* wykrawanych w czasie 1,5 h po uboju i po wychłodzeniu (24 h). Każda grupa doświadczalna składała się z 7 zwierząt: jałowic, wolców i krów. Wykonano pomiary następujących właściwości fizykochemicznych mięśnia: temperatura, pH, jasność barwy, wodochłonność i zawartość wody wolnej. W modelowych kiełbasach drobnorozdrobnionych określono ubytki cieplne oraz ubytki podczas składowania, a także niektóre cechy jakościowe takie jak konsystencję, soczystość i kruchość.

Mięśnie wykrawane na ciepło wszystkich grup doświadczalnych posiadały wyższe pH i wyższą wodochłonność, natomiast dużo niższą zawartość wody wolnej niż mięśnie po wychłodzeniu. Różnice w konsystencji i soczystości kiełbas modelowych były statystycznie istotne. Uzyskane wyniki zostały sprawdzone w skali przemysłowej w produkcji kiełbas parzonych. Wydajność kiełbas produkowanych z dodatkiem wołowiny wykrawanej na ciepło była wyższa niż przy użyciu mięsa wychłodzonego.