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INSTITUTE OF MEAT INDUSTRY SENSORY EVALUATION LABORATORY

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THE EFFECT OF THERMAL PROCESSES UPON THE FLAVOUR OF CANNED MEAT WITH SPECIAL REFERENCE THE CHANGES OF SOME AMINO ACIDS

INTRODUCTION

Flavour is one of the most important quality characteristics of meat products. The development of new analytical methods (mainly gas chromatography) which allow to separate, indentify and estimate a minute quantity of compounds gives the enormous possibilities for the research of flavour chemistry. In the recent years a lot of investigations concerning the chemistry of meat flavour have been done mainly in the USA and Great Britain [3, 4, 8, 9, 10, 12, 14, 23] but the results have very often been contradictory; that follows from the difficulties encountered in these research.

The role of amino acids, fat and other compounds in formation of meat flavour is till now not uniform. As early as in 1948 Crocker [5] pointed to amino acids as a main source of volatile compounds of meat odour which are formed during cooking of meat in cause of decarboxylation or deamination of amino acids. Other authors, namely Wood [28], Hornstein and coworkers [8, 9] consider the Maillard reaction responsible for formation of meat flavour. On the other hand Wirth and Leistner [27] report that undesirable „canned flavour" of sterilized meat products is the result of the Maillard reaction. These authors did not give experimantal support for their suggestion except of the observation of colour i. e. there appeared the brownish stains in canned meat parallely with the increase of intensity of „canned flavour".

The elucidation of the mechanism of the formation of this undesirable flavour of canned meat is very essential from the technological point of view since it is indispensable for the eventual counteraction. Therefore it seems to be interesting to characterize the effect of different conditions of thermal processes (time and temperature) on the flavour of canned meat and to determine the role of some amino acids in the formation of this flavour. From kinetic considerations follows that the degree of decomposition of the sulphur amino acids

should increase with prolongation of heating time as well as with the elevation of heating temperature. The latter dependence should follow the known Arrhenius formula (26). The above said is the hypothesis to be proved in the experiments described below.

I. MATERIALS AND PROCEDURE

From information given in literature [2, 5, 8, 9, 10, 25] one can infer that sulphur amino acids present in meat may be considered as precursors of meat flavour. On this basis one could expect that the addition of said amino acids should either improve the meat flavour or restore it in case of serious damage of the amino acids naturally present in meat caused by so called „overheating". In order to check this a series of preliminary investigations were made in which „meat juices" pressed from minced meat were deprived of these precursors by treating with ion-exchange resins (Amberlite — IRA 400 in Na form or Dowex 50 x-8 in H form) „Juices" treated in this way after heating did not exhibit any meat flavour at all. However the intended experiments on reconstruction of the meat flavour in these „juices" by the addition of pure sulphur amino acids could not be performed because of an off flavour imparted to the „juices" by the ion-exchange resins.

The next experiments showed that the added amino acids (cysteine and lysine as hydrochloride as well as arginine) modified both flavour (its quality and intensity) and colour (various intensity of browning) of „meat juices" after heating in sealed glass tubes.

All further experiments, except the second one, were done on raw meat. In the second experiment cured meat was used. The studies were done on minced meat (*M. longissimus dorsi*) of known ageing degree (ca 72 hours after slaughter) from pigs weighing ca 120—130 kg. The minced meat was packed into varnished cans (200 g batches) which were then heated in water or oil bathes under controlled conditions (temperature, time).

The temperature in the centre of the cans was measured by means of thermocouples and registered on a German M. A. W. recorder.

The studies concerned the effect of the different types of thermal processing (within the temperature range: 95—121°C) on the formation of flavour in the canned meat. Besides, the role of some amino acids upon the flavour was investigated and the changes in the amount of amino acids caused by various thermal processes were determined. The above mentioned tasks were realized in successive experiments: the first two were to characterize the effect of different conditions of the thermal process upon the flavour of experimental canned meat, and the subsequent three to determine the role of amino acid supplementation on the formation of flavour. The details concerning the applied variants of the thermal process and amino acid supplementation in each particular experiments are given in table 1.

In connection with methodological difficulties encountered in preliminary investigations another approach was further applied for the assay of the influence of amino acid supplement on the formation of meat flavour. It was to show whether the addition to meat before canning increased amount of individual investigated amino acids (twice in relation to data of pork loins quoted by Niewiarowicz [18]) had any effect on (if so at what degree and in which direction) the final flavour of experimental canned meat.

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Table 1

The scheme of carried out experiments

Experiments	Parameters of thermal processes 1)	Applied additives	Notes
Experiment I (raw meat)	95°/30′; 103°/30′; 112°/30′; 121°/15′;	—	
Experiment II (cured meat)	95°/15′; 95°/30′; 103°/15′; 103°/30′; 112°/15′; 112°/30′; 121°/0′; 121°/15′;	—	curing according to obligatory technology
Experiment III (raw meat)	121°/0′;	methionine, arginine, lysine · HCl, cysteine · · HCl (1,3 mg% in relation to meat)	addition of amino acids in aqueous solutions to meat before canning (5% addition of water)
Experiment IV (raw meat)	112°/15′	methionine, lysine · · HCl, cysteine · HCl, cysteine · HCl after neutralization, (1 mg% in relation to meat), glutamic acid (2 mg% in relation to meat)	addition of amino acids in aqueous solutions to meat before canning (5% addition of water)
Experiment V (raw meat)	95°/30′; 103°/30′; 112°/0′; 112°/10′; 121°/0′;	— methionine + ribose; cysteine + ribose; the ratio of amino acid to ribose = 1 : 2 (1 mg% addition of each amino acid in relation to meat)	the addition of each sulphur amino acid with ribose in aqueous solution (5% addition of water)

1) In all experiments the conventional way of expressing parameters of thermal processes has been introduced in form of fraction in which a numerator denoted the internal temperature of cans (°C) and denominator denoted the time of maintenance of cans at this temperature (minutes).

II. METHODS

SENSORY EVALUATION METHODS

The sensory evaluation of the canned meat was performed by an experienced laboratory panel consisting of 6—10 persons from among the Meat Research Institute workers. To detect and evaluate the flavour differences the Tukey's method of multiple comparisions was used [15]. This procedure allowed to select judges as well as to evaluate the results by simply „quick and easy" analysis based on the range analysis. Moreover, a 5-point scale according to Tilgner was used to assess the quality of canned meat [24].

CHEMICAL METHODS

The extracts of free amino acids of raw and canned meat were obtained according to the Awapara's method applied by Niewiarowicz [18]. Vacuum condensed extracts were separated by thin layer chromatography, high voltage paper electrophoresis and electrophoresis followed by chromatography.

THIN LAYER CHROMATOGRAPHY

One — or two dimensional ascending chromatography was applied to separate the extracts of free amino acids.

Glass plates were coated with spreader using the suspension of Silica Gel G (according to Stahl) in water. The samples were applied to the Silica Gel by means of the Hamilton microsyringe. The development was done in chromatography tanks using the following single phase solvents:

1. ethanol/water [21],
2. n-butanol/acetic acid/water [21],
3. isopropyl alcohol/amonium hydroxide/water [19].

Developed and dry plates were sprayed with an appropriate ninhydrin reagent i. e. neutral, alkaline or acidified ninhydrin [7] respectively to the used, above mentioned, solvents.

HIGH VOLTAGE PAPER ELECTROPHORESIS AND ELECTROPHORESIS FOLLOWED BY CHROMATOGRAPHY

The quantitative analysis of the assayed free amino acids was performed using the AEF — 1 Polish apparatus. The specimens were applied to Whatman 3 paper following the wetting in appropriate electrolyte solutions: phthalate buffer according to Masłowski [17] or formic-acetic acid buffer [6]. The paper after electrophoresis in acid buffer was chromatographed in perpendicular direction to the electrophoretic motion using the butanol solvent. The papers treated with the appropriate ninhydrin reagent [7] were dipped into Fischer's reagent [11]. The absorbance of complex compounds eluted using methanol was measured on the Zeiss spectrocolorimetr „Specol" at 504 mμ wave length. The mixtures of standard amino acids were treated in analogous way. The amount of each amino acid was determined on the basis of a relation ranged out for different concentrations of standards. The estimation of specimens and standard amino acids was carried out in several replicates.

DETERMINATION OF SULPHYDRYL GROUPS IN CANNED MEAT

SH groups were determined according to the nitroprusside method [13]. The measurements of absorbance were performed on the „Specol" spectrocolorimeter at 520 mμ wave length within 40—50 seconds since development of the colour. The amount of SH groups was determined according to the calibration curve for cysteine.

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III. RESULTS AND DISCUSSION

THE EFFECT OF THE TYPE OF HEATING PROCESS ON THE FORMATION OF CANNED MEAT FLAVOUR

The data of two experiments (I and II) concerning the effect of thermal processes upon flavour of canned meat are shown in table 2,3 and 3a. The results in table 2 indicate that the applied variants of thermal process modify significantly the flavour of canned meat. The analysis of the conditions of the thermal process (Table 3 and 3a) indicates clearly that the applied temperature is the main factor modifying the flavour whereas the duration time of the heating — although increasing the changes in the flavour does so to a much smaller extent. Such

Table 2

The differences (expressed in form of differences of totals for individual treatments) o flavour of canned meat submitted different thermal processes (experiment I)

	95°/30′ control	103°/30′	112°/30′	121°/15′
95°/30′	—	20	100*	192*
103°/30′		—	80*	182*
112°/30′			—	102*
121°/15′				—

The least significant difference (L.S.D.= = 46.62) at the 5% level of significance.
* — significance at the 5% level.

Table 3

The differences (expressed in form of differences of totals for individual treatments) of flavour of canned meat submitted different thermal processes (experiment II)

Sensory evaluation of canned meat was carried out after one and half monthly storing in refrigerator

95°/30′ control 1	95°/15′ 2	103°/15′ 3	103°/30′ 4	112°/15′ 5	112°/30′ 6	121°/0′ 7	121°/15′ 8
1. —	8	21*	52*	57*	61*	89*	86*
2.	—	13	44*	49*	53*	81*	78*
3.		—	31*	36*	40*	68*	65*
4.			—	5	9	37*	34*
5.				—	4	32*	29*
6.					—	28*	25*
7.						—	3
8.							—

The least significant difference (L. S. D. = 16.34) at the 5% level of significance.
* — significance at the 5% level.

results are in excellent conformity with those expected in the hypothesis mentioned in the introduction. If we suppose the decay of each of the sulphur amino acid follows the first order reaction, then its actual concentration in canned meat can be written as follows:

$$x = x_o \cdot e^{-kt} \qquad [26]$$

where:

x — concentration of indivudual amino acid,
t — time of heating,
k — velocity or rate constant for the reaction.

In the above formula the rate constant is related to the temperature through the well known Arrhenius equation; i. e.

$$k = Ae^{-E/RT}$$

where:

k — reaction rate constant,
A — constant specific to the reaction,
E — energy of activation,
R — gas constant,
T — temperature (°Kelvin).

Inserting this equation into the formula for x it can be understood why the effect of temperature must be more profound than that one exerted by the heating time.

Table 3a

The differences (expressed in form of differences of totals for individual treatments) of flavour of canned meat submitted different thermal processes (experiment II)

Sensory evaluation of canned meat was carried out after six monthly storing in refrigerator

	95°/30′ control	95°/15′	103°/15′	103°/30′	112°/15′	112°/30′	121°/0′
95°/30′	—	3	15	40*	89*	88*	92*
95°/15′		—	12	37	86*	85*	89*
103°/15′			—	25	74*	73*	77*
103°/30′				—	49*	48*	52*
112°/15′					—	1	3
112°/30′						—	4
121°/0′							—

The least significant difference (L.S.D. = 37.40) at the 5% level of significance.
* — significance at the 5% level.

The effect of amino acid supplement upon the flavour of canned meat Tables 4, 5, 5a, 6 illustrate the received results and show that the added amino acids modify significantly the flavour of the canned meat. Both methionine and lysine reduce extensively the flavour acceptability of canned meat. However, the more strict sensory evaluation of products of the Maillard reaction of the individual amino acids indicates that products of lysine degradation do not resemble meat flavour, whereas methionine and first of all cysteine give products which undoubtedly are meat flavour compounds. It should be stressed here that odour evaluation of the Maillard reaction products shows the sensoric activity of methionine to be the most pronounced when compared with that of other amino acids: cysteine, cystine, lysine and tryptophan.

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°/30′	112°/15′	112°/30′	121°/0′
40*	89*	88*	92*
37	86*	85*	89*
25	74*	73*	77*
—	49*	48*	52*
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For this reason it seemed to be interesting to investigate the changes of these and other free amino acids in canned meat during the thermal processes.

Preliminary separation of the extracts of free amino acids by thin layer chromatography, using one-way ascending technique in 3 different solvents, shows

Table 4

Comparative evaluation according to the 5-point scale of experimental canned meat (with addition of amino acids) heated to reach at the centre of cans 121 °C (experiment III)

Kind and amount of added amino acid (mg% in relation to meat)	Mean seores for quality characteristics	
	odour acceptability	flavour acceptability
Control sample without addition of amino acid	4.8	4.4
addition of methionine (1,3 mg%)	3.9	3.0
addition of arginine (1,3 mg%)	3.9	3.4
addition of lysine · HCl (1,3 mg%)	3.7	2.9
addition of cysteine · HCl (1,3 mg%)	3.9	3.5

that the amount of amino acids and low peptide fraction decreases with the rising of heating temperature (fig. 1, 2, 3). It is marked in the sample sterilized at the temperature 121°C.

However, even the best one-way separation in isopropyl alcohol solvent (11 spots) and two-way chromatography is not sufficient for quantitative analysis. The separation and estimation of amino acids is carried out using high voltage

Table 5

The differences (expressed in form of differences of totals for individual treatments) of flavour of canned meat with addition of different amino acids (experiment IV)

The same thermal process — 112 °/15′

Sensory evaluation of experimental canned meat was carried out after monthly storing in refrigerator

112°/15′ control	addition of methionine 1 mg%	addition of lysine · HCl 1 mg%	addition of cysteine · HCl 1 mg%	addition of cysteine · HCl after neutralization 1 mg%
1	2	3	4	5
1 —	31*	35 *	45 *	51 *
2	—	4	14	20 *
3		—	10	16
4			—	6
5				—

The least significant difference (L.S.D. = 17.64) at the 5% level of significance.
* — significance at 5% level.

paper electrophoresis followed by chromatography. The identification of spots is based on the relative electrophoretic mobilities in relation to alanine. The obtained data (29) are consistent with Atfield's and Morris results (1). The map of standards of amino acids and separation of free amino acids of canned meat heated to reach 121°C in the centre of the can are shown exemplarily on photographs (fig. 4 and 5), respectively. The changes of amino acids during thermal

Table 5a

The differences (expressed in form of differences of totals for individual treatments) of flavour of canned meat with addition of different amino acids (experiment IV)

The same thermal process — 112 °/15′

Sensory evaluation of experimental canned meat was carried out after two monthly storing in refrigerator

	112°/15′ control	addition of methionine 1 mg%	addition of lysine · · HCl 1 mg%	addition of cysteine·HCl 1 mg%	addition of cysteine·HCl after neutralization 1 mg%	addition of glutamic acid 2 mg%
1	—	31 *	22 *	48 *	39 *	28 *
2		—	9	17 *	8	3
3			—	26 *	17 *	6
4				—	9	20 *
5					—	11
6						—

The least significant difference (L.S.D. = 12,48) at the 5% level of significance.
* — significance at the 5% level.

processes in comparision with raw meat are presented in Fig. 6 and 7 (the results are the averages of several separations). As data show, there is a decay of amino acids except glycine as the temperature increases. The amount of glycine increases in comparision with raw meat during the thermal process at lower temperature (95°/30′) and then decreases reaching the level of raw meat.

Table 6

Comparative evaluation of experimental canned meat according to 5-point scale (experiment V)

Variants of thermal process and applied additives	Mean scores for quality characteristics				
	Odour		Flavour		Overall quality
	intensity	acceptability	intensity	acceptability	
95°/30′	4.1	3.9	4.2	4.0	4.1
103°/30′	3.7	3.8	4.0	3.8	3.8
112°/0′	4.1	3.7	4.0	3.5	3.7
112°/10′	3.7	3.9	3.9	3.7	3.8
121°/0′	4.4	3.3	4.1	2.9	3.1
121°/0′ sample with addition of methionine and ribose	4.7	3.0	4.2	2.5	2.7
121°/0′ sample with addition of cysteine and ribose	4.4	3.2	3.9	2.9	3.1

ɔgraphy. The identification of spots ɔbilities in relation to alanine. The d's and Morris results (1). The map of free amino acids of canned meat an are shown exemplarily on photo- ıges of amino acids during thermal

Table 5a

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addition of cysteine.HCl 1 mg%	addition of cysteine.HCl after neutralization 1 mg%	addition of glutamic acid 2 mg%
48 *	39 *	28 *
17 *	8	3
26 *	17 *	6
—	9	20 *
	—	11
		—

D. = 12,48) at the 5% level of

presented in Fig. 6 and 7 (the s). As data show, there is a decay re increases. The amount of glycine ing the thermal process at lower ng the level of raw meat.

Table 6

l meat according to 5-point scale

cores for quality characteristics			
ta- y	Flavour		Overall quality
	intensity	acceptability	
	4.2	4.0	4.1
	4.0	3.8	3.8
	4.0	3.5	3.7
	3.9	3.7	3.8
	4.1	2.9	3.1
	4.2	2.5	2.7
	3.9	2.9	3.1

The parallel decrease of surface and intensity of spot, probably glutathione, nd the smaller content of SH groups indicate that the decomposition of this ipeptide may be responsible for the above mentioned increase of the glycine ontent. The decay of alanine during heating is the greatest but that of the

Figure 1. Separation of free amino acids of raw and canned meat by thin layer chromatography. Chromatoplate developed by one-dimensional asceding chromatography in isopropyl alcohol solvent:

isopropyl alcohol : H_2O : NH_4OH [19]
7 : 2 : 1 w/w

Successive digits denote the separation of free amino acids of the following samples: *I* — raw meat, *II* — canned meat 95°C/30′, *III* — canned meat 103°C/30′, *IV* — canned meat 121°C/0′, *V* — the Shandon's mixture of 18 amino acids

remaining amino acids is much smaller. Since sulphur amino acids and their decomposition products are of great interest in our studies, the sulphydryl groups and hydrogen sulphide are parallel determine in canned meat. As data show (Fig. 8) the decrease of SH groups with rising temperature causes simultaneously the growth of hydrogen sulphide [20]. Sowa [22] has shown that heating the meat in the high frequency field within the range of temperature 90—150°C causes

a great decomposition of SH groups. The cysteine which in our studies has been added to minced meat before canning together with ribose (experiment V) is decomposed in 75% during sterilization (121°/0′); it seems that ribose is the stimulator of this decomposition.

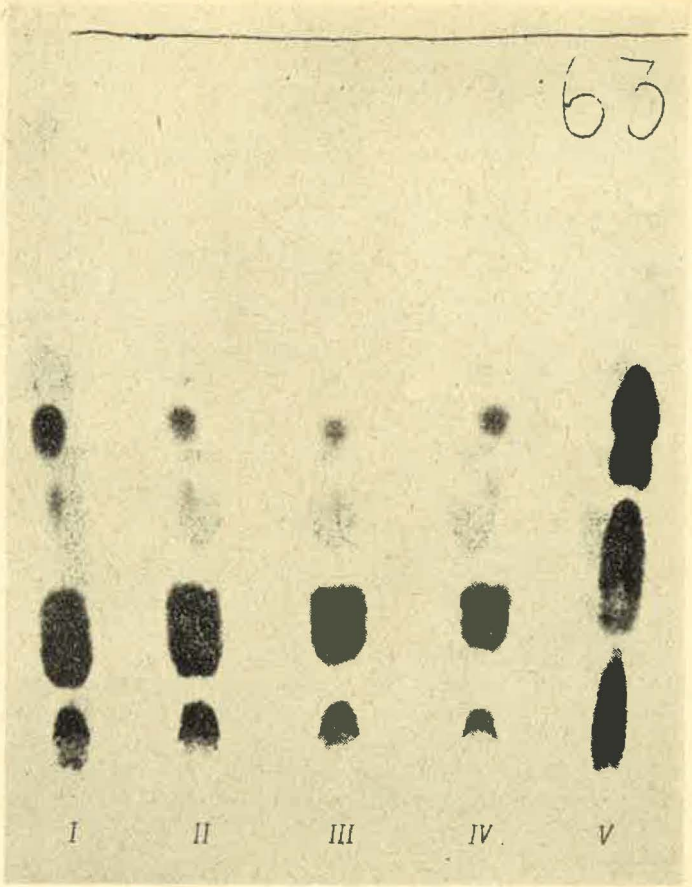

Figure 2. Separation of free amino acids of raw and canned meat by thin layer chromatography. Chromatoplate developed by one-dimensional asceding chromatography in butanol solvent:

n-butanol : acetic acid : water [21]
60 : 20 : 20 w/w

Successive digits denote the separation of free amino acids of the following samples: *I* — raw meat, *II* — canned meat 95°C/30′, *III* — canned meat 103°C/30′, *IV* — canned meat 121°C/0′, *V* — the Shandon's mixture of 18 amino acids

From the results concerning the volatile sulphur compounds (RSH and H_2S) and sensory evaluation of odour and flavour acceptability, carried out on the same canned meat (experiment V) follows that there exists a significant negative correlation between the quantity of mercaptans and hydrogen sulphide from one side and the scorings from the other [20]. As Ballance has shown [2] and Martin's and coworkers' investigations have confirmed [16] methionine is the main source of mercaptans. As was mentioned above the evaluation of odour of the Maillard

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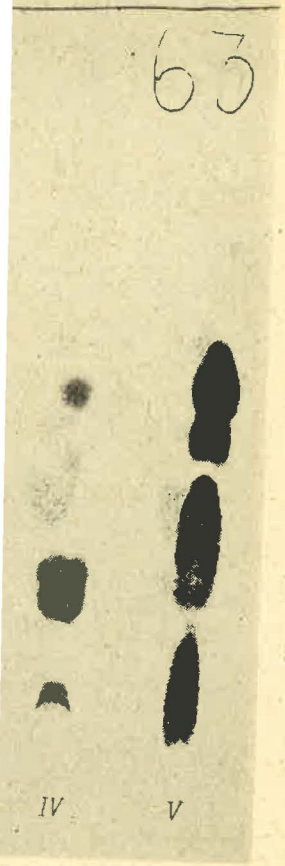

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eaction products of methionine shows greater sensory activity than the other mino acids. This is in agreement with the low value of the regression coefficient or mercaptans related to odour and flavour acceptability of canned meat [20].

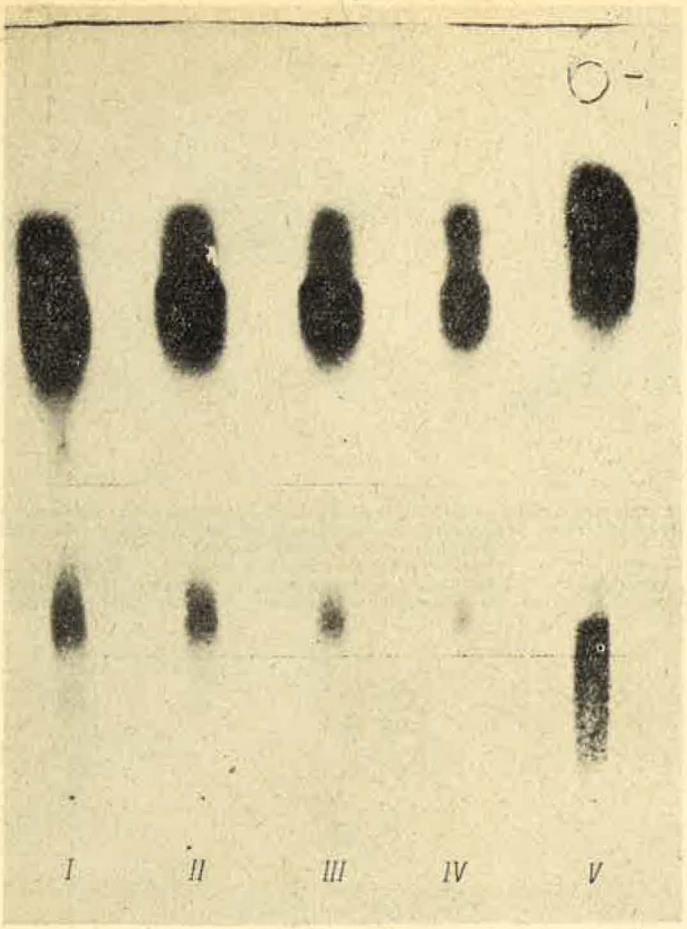


Figure 3. Separation of free amino acids of raw and canned meat by thin layer chromatography. Chromatoplate developed by one-dimensional asceding chromatography in ethanol solvent:
ethanol : water [21]
63 : 37 w/w
Successive digits denote the separation of free amino acids of the following samples: *I* — raw meat 95°C/30′, *II* — canned meat 95°C/30′, *III* — canned meat 103°C/30′, *IV* — canned meat 121°C/0′, *V* — the Shandon's mixture of 18 amino acids

Similar data are obtained for hydrogen sulphide but the values of the regression coefficient are much higher [20] what shows that the same increase of mercaptans decreases much more the sensory quality of canned meat than hydrogen sulphide.

Thus, even a small decomposition of methionine and a greater one of cysteine during thermal process with simultaneous increase of volatile sulphur compounds — mercaptans and hydrogen sulphide — is contributing highly to the formation of the undesirable „canned meat" flavour.

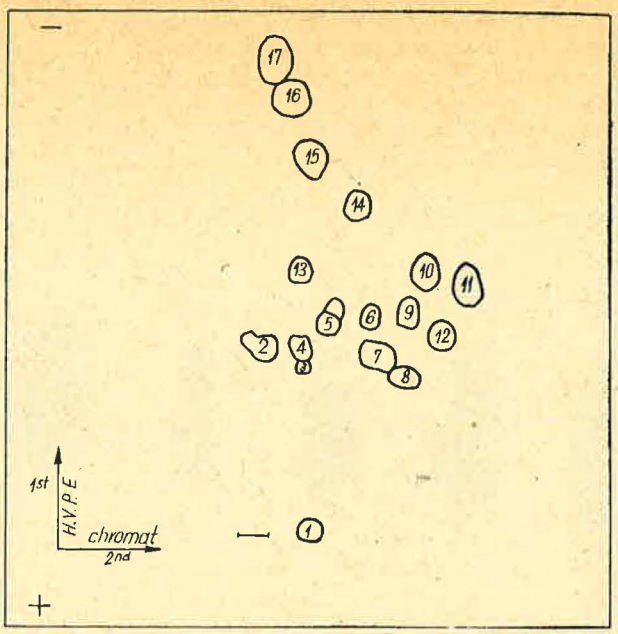


Figure 4. Map of standard amino acids obtained by H.V. electophoresis followed by chromatography: 1 st electrophoretic separation in formic-acetic acid buffer, 2nd chromatography development in butanol solvent

1 — taurine, *2* — cystine, *3* — hydroxyproline, *4* — aspartic acid, *5* — glutamic acid+threonine, *6* — proline, *7* — tyrosine, *8* — tryptophan, *9* — methionine, *10* — valine, *11* — leucine+isoleucine, *12* — phenylalanine, *13* — serine, *14* — alanine, *15* — glicine, *16* — histidine+arginine, *17* — lysine

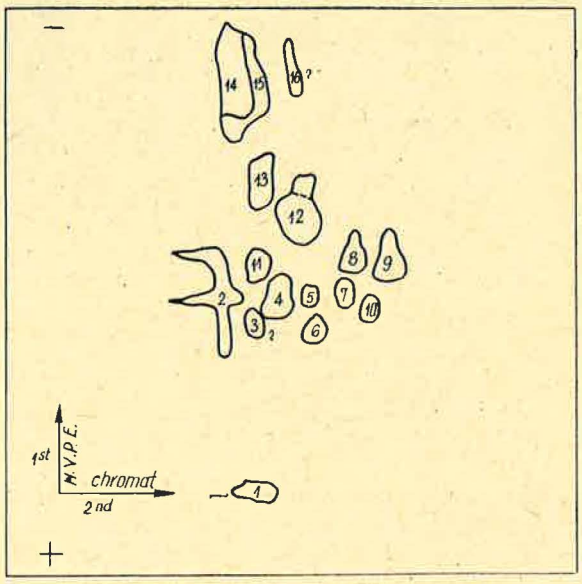
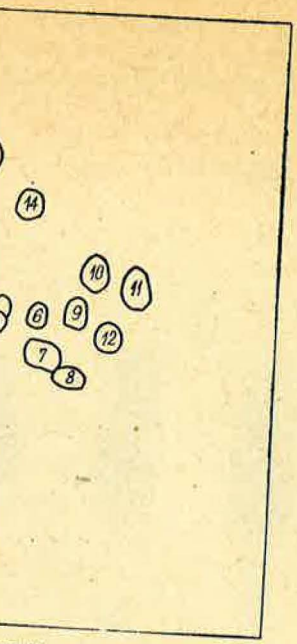
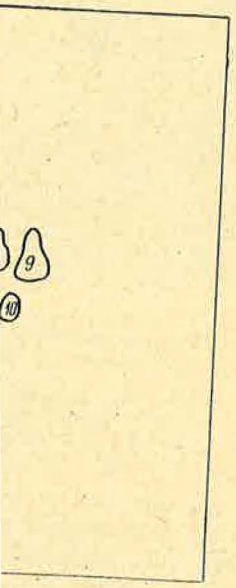


Figure 5. Separation of free amino acid of canned meat (121°C/0′) obtained by H.V. electrophoresis followed by chromatography

1 — taurine, *2* — cysteine+cystine (tail), *3* — glutathione? *4* — glutamic acid+glutamine+threonine, *5* — proline, *6* — tyrosine, *7* — methionine, *8* — valine, *9* — leucine+isoleucine, *10* — phenylalanine, *11* — serine, *12* — alanine, *13* — glycine, *14* — basic dipeptides — carnosine, *15* — basic amino acids, *16* — unidentifield spot



H.V. electophoresis followed by chromato-
-acetic acid buffer, 2nd chromatography
nol solvent
spartic acid, 5 — glutamic acid+threonine,
nine, 10 — valine, 11 — leucine+isoleucine,
licine, 16 — histidine+arginine, 17 — lysine



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e, 8 — valine, 9 — leucine+isoleucine,
ne, 14 — basic dipeptides — carnosine,
identifield spot

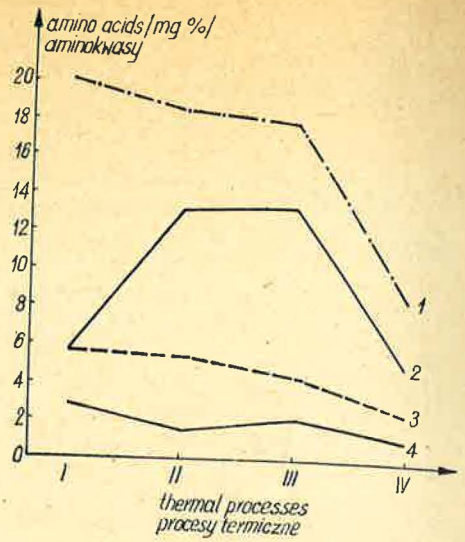
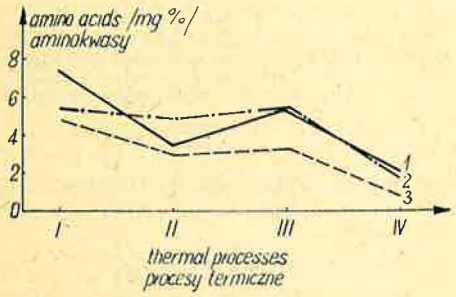


Figure 6. The effect of thermal processes on the free amino acids content in canned meat: *I* — raw meat, *II* — canned meat 95°C/30′ *), *III* — canned meat 103°C/30′, *IV* — canned meat 121°C/0′
*) Conventional way of expressing thermal process: internal temperature (°C) / time of maitenance of cans at this temperature (minutes)
1 — alanine, *2* — glycine, *3* — cystine, *4* — methionine



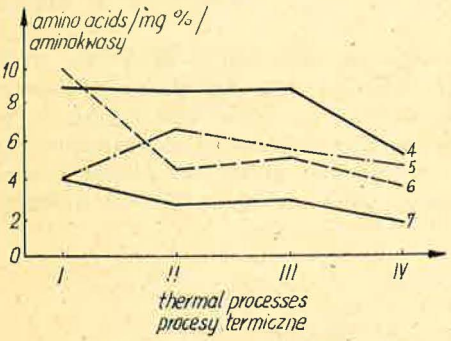


Figure 7. The effect of thermal processes on the free amino acids content in canned meat: *I* — raw meat, *II* — canned meat 95°C/30′ *), *III* — canned meat 103°C/30′, *IV* — canned meat 121°C/0′
*) Conventional way of expresing thermal process: internal temperature (°C) / time of maitenance of cans at this temperature (minutes)
1 — tyrosine, *2* — serine, *3* — phenylalanine, *4* — glutamic acid+glutamine, *5* — arginine+ +lysine, *6* — leucine+izoleucine, *7* — valine

IV. CONCLUSIONS

1. Analysing the effect of conditions of the thermal process upon the flavour of canned meat in the range of 95—121°C it is found that the main factor modifying the flavour is the temperature to which the canned meat is heated. The time of exposing the meat to any given temperature is of less significance.

2. It is found that the applied variants of thermal process causes the changes in the quantity of free amino acids in canned meat. As the temperature of thermal processing increases the amount of the individual amino acids decreases in general. The changes within 95—103°C are rather small; much greater decay occurs

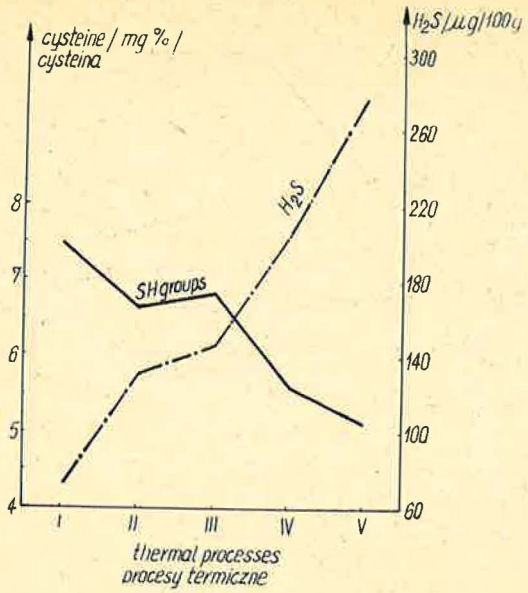


Figure 8. The effect of thermal processes on the content of SH groups and hydrogen sulphide in canned meat: *I* — canned meat 95°C/30′ *), *II* — canned meat 103°C/30′, *III* — canned meat 112°C/0′, *IV* — canned meat 112°C/10′, *V* — canned meat 121°C/0′,

*) Conventional way of expressing thermal process: internal temperature (°C) / time of maintenance of cans at this temperature (minutes)

in canned meat heated to 121°C. Glycine is an exception; its quantity initially increases and then decreases reaching in canned meat heated to 121°C the same level as in raw meat.

3. It is found that as the temperature of thermal process increases (from 95° to 121°C) there takes place the decay of SH groups. Moreover the cysteine added together with ribose to minced meat before canning is decomposed in 75% in canned meat heated to 121°C.

4. The addition of sulphur amino acids and other ones had a significant effect upon the flavour of canned meat. Additionally carried out odour evaluation of the Maillard reaction products of individual amino acids with ribose shows the sensory activity of methionine to be the most pronounced in comparision with other amino acids, among which mainly cysteine and at to less degree cystine and methionine give products resembling undoubtedly the odour of meat products.

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