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THE EFFECT OF HEAT TREATMENT ON THE CHEMICAL COMPOSITION OF CANNED MEAT

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ABSTRACT

Beef, pork and chicken meat were used in this study. Heat treatments were carried out at 115°C in stationary and rotating autoclaves, 125°C in stationary and rotating autoclaves, 125°C in stationary and 125°C but higher Fo value in stationary and rotating autoclaves.

The results of the analysis showed higher protein values in the range of 20.54% to 23.92% (autoclaved) and 20.25% to 20.85% (raw) beef; those of pork samples were from 19.12% to 21.68% (autoclaved), 19.19% to 19.83% (raw) while chicken samples were from 22.00% to 24.76% (autoclaved) and raw sample is 20.75% respectively. In the case of fat content, autoclaved beef samples showed higher values than the raw samples in the range of 3.0% to 4.5% (autoclaved), 1.0% to 1.5% (raw), while the reverse was the case with pork and chicken where the range for pork was from 2.5% to 5.0% (autoclaved), 5.0% to 5.5% (raw), and chicken from 0.5% to 2.0% (autoclaved) and 2.5% (raw) samples respectively. The ash content of autoclaved beef and pork samples showed lower values than their raw samples and were in the range of 1.13% to 1.53% (autoclaved) and 1.01% to 1.74% (raw) for beef and 1.20% to 1.62% (autoclaved), 1.14% to 1.68% for raw pork samples while autoclaved chicken samples showed higher values than the raw sample in the range of 1.20% to 1.62% (autoclaved) and 1.02% raw samples respectively. Apart from two autoclaved pork samples SA3 (stationary) and SF5 (rotating) that showed higher moisture content than their raw samples other pork samples (SAI, BF2, SA4) beef and chicken samples showed lower values. The moisture content of pork sample (SA3) was 76.5% (autoclaved) 72.0% (raw) SF5 sample was 75.0% (autoclaved) and 73.0% (raw) respectively.

Amino acid content of the sample also showed that by far a higher effect exists with the behaviour of individual amino acid of the raw material than the parameters of heat treatment. In all product samples cystein and tryptophan contents of autoclaved samples were lower than those of the raw samples.

The amino acid range for beef were from 99.24g to 99.98g (autoclaved), 100.00g to 103.90g (raw); pork samples 102.24g (raw); chicken samples 99.99g to 100.01g (autoclaved) and 100.01g for raw samples respectively.

Thiamine retention was higher in canned beef than other canned meat. More thiamine was retained in autoclaved pork in rotation than in autoclaved stationary treatment. Thiamine in beef ranged from 0.85g to 1.20mg (autoclaved), 1.86mg to 2.50mg (raw samples); pork 0.44mg to 0.81mg (autoclaved) and 1.19mg to 1.80mg (raw); chicken 0.06mg to 0.10mg (autoclaved) and 1.25mg for raw sample respectively. The result on thiamine retention showed that, that of canned chicken was more sensitive to heat treatment than other canned meat samples.

On the whole, the results of this study showed that products heating largely by conduction-stationary heat treatment-resulted in acceptable quality meat products.

KEY WORDS: Heat treatment, canned meat, chemical composition, thiamine retention.

INTRODUCTION

Heat treatment is one of the most frequently used methods in meat processing technology. The extent of heat treatment is, however, limited by the preservation of organoleptic and nutritional palatability.

The production of animal protein has been insufficient to meet the demands in developing countries (F.A.O. 1970). Specifically, livestock production in these countries is increasing at between 1.5 and 2.0% per annum while demand is growing at 4 to 5% annually. Consequently, F.A.O. (1970) called for an increase in production and recommended intensified management of wild as well as domestic stocks.

The meat processing industry is a growing one and the few processors available concentrate on the use of beef, chicken and pork to produce fresh meat, frozen meat, bacon, sausages, sausage meat and ham.

The shortage of dietary proteins, specifically those of animal origin, is one of the greatest problems facing Nigeria today. This shortage is having adverse effect on the economic development of the country not only in terms of reduced human productivity, but also in the high incidence of infant mortality, severe

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malnutrition and precipitated diseases.

The demand for meat as a component of every household diet which was on the increase in the 1970s is now showing a rapid decrease. The reasons include the high inflation rates, Structural Adjustment Programme which has resulted in a lower value for the naira and the rapid increase in human population. Educating Nigerians on better nutrition has not been able to change the downward trend. Except government intervenes, the future of meat supply in Nigeria is bleak. It becomes, therefore necessary that appropriate technology should be used during meat processing in order to preserve the protein and other valuable component.

Although a lot of meat products are being consumed, investigations into changes in their nutritive value have mostly been concentrated on household preparation. Experts in the food industry have mainly investigated those properties of meat which are important from an industrial point of view.

The effect of processing food products using high temperature heating in autoclave needs large scale investigation. A lot of interest has been demonstrated in this area by the volume of work published so far (Bender, 1966; Lawrie, 1968; Cheftel and Thomas 1963; Charm, 1971; Tarjan and Linder, 1981; Lawrie, 1966; Lund, 1977; Len and Lund 1980, Eneji 1976, 1985; Zukal, 1970.

MATERIALS AND METHODS

MATERIALS USED

Beef, pork and chicken breast from which the bones, tendons, surface connective tissues and fat had been removed were used. The beef and pork used were from the biceps femoris muscle of the animal.

Preparation of Samples

The different types of meat were washed with flowing warm tap water. The meats were later cut into cubes of 24 x 24mm through a 24mm disc. The prepared meat of each type was mixed with 10g/kg common table salt. Four hundred gram (400g) of mixed meat was filled into 500g, of internally lacquered can (Ø99 x 60mm) with Vemag filling machine and sealed hermatically.

Part of the samples were sterilized in the Research Institute for Canning and Paprika Industry while the remaining part was sterilized in the Budapest Canning Factory.

The samples without heat treatment control-were stored frozen until chemical investigations were carried out.

Heat treatment in stationary and Rotating autoclaves:

The different types of canned meat were sterilized in the STOCK PILOT ROTOR, model 900 laboratory autoclave. Rotation number can be altered between 0 and 30min^{-1}. Also LW 2002 LUBECA stationary sterilizing equipment was used under factory conditions.

All product types received five types of heat treatments at 115°C and the applied 125°C in modern equipment in stationary as well as rotational positions. Higher Fo-value at 125°C sterilization was also carried out.

Investigations for tropical stability, according to the above scheme of sterilized products in a thermostat (55 +- 1°C, 21 days) was carried out.

Chemical investigations

Samples of each sterilized meat type was minced and homogenized with moulinette model turmix machine before laboratory analysis.

Determination of crude protein

The Association of Officia Analytical Chemists (A.O.A.C, 1975) method of crude protein analysis was used in the determination of crude protein content.

An aliquot part from the carefully homogenized sample was digested with sulphuric acid in the presence of selenium catalyst.

The protein content from the digested sample was determined with KJELTEC AUTO 1030 analyzer.

DETERMINATION OF MOISTURE CONTENT

A.O.A.C., (1975) method of analysis was used in moisture determination.

Determination of Ash content

The method of A.O.A.C., (1975 was used for the estimation of ash content.

Determination of Amino acids

MOORE-STEIN method was used to analyse the samples. The samples were hydrolized with hycrochloric acid (HCl) at 110°C (Kerese, 1975). After the distillation of the hydrochloric acid, the amino acids in the samples were determined with AAA881 type amino acid analyzer. The analyzer has one ion exchange column which is filled with sulphurnated polysterol resin. The eluent were different pH sodium citrate buffer solutions.

During the elution at a suitable temperature, the solutions were mixed with ninhidrin and the evolving colour intensity gave a suitable signal which was recorded with the help of the recording equipement. Suitable curves of the amino acid compositions were formed from the equipment signal. The curves' peak areas were evaluated by calculations and comparing them with known standards. To determine tryptophan, modified hydrolysing agents were used. The hydrochloric acid (HCl) was replaced with P-toluence sulphonic acid.

Determination of Fat content

The fat content was determined by the quick method-butyrometer, (Hungarian Standard, 1972).

Determination of thiamine

The thiamine content of the samples was determined by High Pressure Liquid Chromatographic (HPLC) method. All the samples were extracted with 0.1M HCl for half an hour on a water bath. After cooling to room temperature, M sodium acetate was added and the pH was adjusted to 4.5. Ten percent (10%) takadiastase enzyme solution was added to the sample. The sample was maintained in a thermostat controlled water bath with mild intermitent mixing at 45°C for one hour. After cooling to room temperature, the sample was centrifuged, and the volume adjusted with 0.1 N hydrochloric acid.

The HPLC equipment was manufactured by WATER ASSOCIATES.

Detection: With ultra violet absorption measurement.
Flow Rate: 1Cm3/second.
Fill of pre and separating column: Partisil ODS
Stationary elution and Recorder: MTA KUTSEZ Model 175
Eluents: 0.2M triethyflamin-acetate of pH 4.5-5.5 containing 7.5-30% methanol in deionized distilled water.
Completely randomise design was used to analyse the data.

RESULTS AND DISCUSSION

EFFECT OF HEAT TREATMENT ON CHEMICAL COMPOSITION

The results of proximate analysis of canned meat table 1 showed higher protein values in the range of 20.54% to 23.92% (autoclaved) and 20.25% to 20.85% (raw) beef; that of pork samples were from 19.12% to 21.68% (autoclaved), 19.19% 19.83% (raw); while chicken samples were from 22.00% to 24.76% (autoclaved) and raw sample was 20.75% respectively.

Table 1: Protein, Ash, Fat and Water Content of Canned Meat (%)

Product Designation	Water Content	Protein Content	Fat Content	Ash Content
M	75.5	20.25	1.0	1.74
MA1	72.0	20.75	4.0	1.34
MF2	68.0	22.70	4.0	1.18
M	74.0	20.71	1.5	1.01
MA3	74.0	23.92	3.0	1.33
M	75.0	20.85	1.5	1.48
MA4	72.5	20.54	4.5	1.54
MF5	70.5	22.74	4.0	1.13
S	72.5	19.83	5.5	1.40
SA1	72.5	21.57	5.0	1.20
SF2	71.5	21.68	3.0	1.43
S	72.0	19.60	6.5	1.11
SA3	76.5	19.12	2.5	1.50
S	73.0	19.19	6.0	1.68
SA4	72.5	20.13	2.5	1.58
SF5	75.0	19.30	2.5	1.62
C	75.0	20.75	2.5	1.02
CA1	71.5	24.76	1.0	1.30
CF2	72.5	22.71	0.5	1.48
CA3	71.5	23.44	2.0	1.62
CA4	73.0	22.00	2.0	1.20
CF5	73.5	22.06	1.0	1.38

Product	115°C Stationary	115°C Rotating	125°C Stationary	125°C Stationary	125°C Rotating	Fresh
Beef	MA1	MF2	MA3	MA4	MF5	M
Pork	SA1	SF2	SA3	SA4	SF5	S
Chicken	CA1	CF2	CA3	CA4	CF5	C

Table 2: Free Amino Acid Composition of Canned Meat Related to its Protein Content

Amino Acids	/g/ amino acid/100g protein/ M	MA1	MF2	M	MA3	M	MA4	MF5
ASP	13.20	11.83	13.72	13.69	9.99	10.64	13.90	10.95
Thr	5.92	5.92	5.75	5.62	5.31	5.57	6.57	6.12
Ser	4.29	4.61	4.58	4.24	4.62	4.67	4.79	4.18
Glu	18.06	18.22	17.71	18.02	19.55	5.62	17.58	12.40
Pro	5.97	5.41	5.33	6.02	5.69	5.02	6.05	7.45
Gly	3.90	5.39	4.44	3.95	5.43	5.76	4.52	4.26
Ala	4.99	5.39	4.96	4.85	5.82	9.01	4.69	4.18
Cys	0.47	0.40	0.28	0.59	0.25	1.34	0.32	0.78
Val	2.85	3.48	3.07	2.78	3.32	3.69	2.95	3.64
Met	2.40	2.14	2.11	2.16	2.13	2.74	2.08	3.32
Ile	3.27	3.19	2.61	2.88	2.85	3.19	2.92	3.36
Leu	8.34	6.66	8.25	7.73	6.69	4.88	7.99	5.59
Tyr	2.73	2.99	3.17	2.90	3.06	3.01	3.07	3.84
Phe	3.59	3.26	3.59	3.37	3.25	4.12	3.38	3.73
Lys	9.60	9.77	9.66	9.50	8.88	8.72	9.00	11.32
His	4.25	4.48	4.24	4.32	4.15	4.72	3.46	3.53
Try	0.64	0.54	0.61	0.92	0.86	1.07	0.63	0.59
Arg	5.55	6.30	5.87	6.47	7.09	8.13	6.34	7.92
Total	100.02	99.98	9.95	100.00	99.24	103.90	99.90	99.46

Table 2: Continued

Amino Acids	S	SA1	SF2	S	SA3	S	SA4	SF5
Asp	9.72	8.88	14.85	9.93	11.03	10.55	11.18	12.05
Thr	4.14	4.44	56.50	5.12	7.09	4.42	5.26	6.16
Ser	4.09	3.25	5.76	4.67	6.16	3.71	4.08	4.73
Glu	11.20	11.48	10.75	11.24	13.28	14.21	12.09	23.25
Pro	7.89	8.23	6.93	8.28	6.91	5.66	8.18	6.98
Gly	5.45	5.17	4.89	5.38	4.62	4.98	5.01	4.88
Ala	5.61	5.79	4.56	5.48	4.96	6.34	5.45	5.70
Cys	1.13	1.46	1.36	1.50	1.25	0.87	0.96	1.00
Val	4.46	4.02	4.74	4.03	5.49	3.85	4.05	5.00
Met	3.58	4.01	1.78	3.80	2.36	2.88	3.94	2.46
Ile	3.18	3.26	1.83	3.16	2.61	4.00	3.95	2.29
Leu	8.03	7.46	6.60	7.86	6.73	8.10	6.11	6.63
Tyr	3.54	3.83	3.33	3.73	3.48	3.58	3.30	3.03
Phe	3.28	3.59	3.91	3.37	4.07	4.03	2.92	3.02
Lys	11.60	10.60	9.73	10.66	8.51	10.27	8.95	8.94
His	5.27	5.80	4.89	5.24	3.89	3.68	5.41	5.78
Try	1.01	0.69	0.68	0.71	0.80	1.40	1.28	0.87
Arg	6.82	8.08	6.90	5.87	6.77	7.71	7.83	6.27
Total	99.99	99.99	99.99	100.03	100.01	102.24	99.95	100.01

Table 2: Continued

Amino Acids	C	CA1	CF2	CA3	CA4	CF5
Asp	10.18	12.28	10.86	11.92	11.71	11.53
Thr	5.31	5.85	5.88	5.96	4.91	5.83
Ser	4.29	5.12	5.12	4.94	4.69	4.74
Glu	14.36	11.12	10.31	12.66	12.64	11.61
Pro	5.09	5.14	5.97	6.58	4.63	5.24
Gly	3.96	4.77	4.87	5.10	4.84	5.63
Ala	6.06	5.96	5.44	4.82	5.32	6.05
Cys	1.05	0.56	0.80	0.84	0.78	0.93
Val	3.62	4.02	4.07	3.66	3.77	4.27
Met	2.99	3.79	3.85	3.96	3.06	3.72
Ile	2.96	3.40	4.20	4.09	3.37	3.49
Leu	7.44	7.12	6.80	6.18	6.83	6.63
Tyr	4.08	3.99	4.18	3.92	3.88	3.88
Phe	4.16	3.59	3.73	3.63	4.01	3.60
Lys	9.31	10.61	10.63	10.10	9.86	10.01
His	4.87	4.62	4.52	4.57	5.36	4.65
Try	2.08	1.10	1.19	1.32	1.45	1.24
Arg	8.20	6.97	7.57	6.75	8.87	7.05
Total	100.01	100.01	99.99	100.00	100.01	100.00

There was no significant difference ($P > 0.05$) in fat content between the raw samples of beef but compared to the results obtained from the heat treated samples, the fat content of the heat treated samples were relatively higher in the range of 3.0% to 34.5% (autoclaved) and 1.0% to 1.5% (raw) respectively. The results of the ash content of beef samples ranged from 1.13% to 1.53% (autoclaved), and 1.01% to 1.74% (raw); while the moisture content ranged from 68.0% to 74.0% (autoclaved) and 74.0% t 75.5% respectively.

Apart from the two autoclave pork samples SA3 (stationary) and SF (rotating) that showed higher moistur content than their raw samples othe pork samples showed lower values. Th moisture content of pork sample (SA3 was 76.5% (autoclaved), 72.0% (raw SF5 sample was 75.0% (autoclaved and 73.0% (raw) respectively. Ther was no significant difference ($P > 0.05$ in fat content between the raw por samples but the heat treated sample showed lower values comapred to th raw samples in the range of 2.5% t 5.0% (autoclaved), 5.0% to 5.5% raw samples respectively.

The moisture content in the cas of the chicken meat samples showe lower values than the raw samples. th range were from 71.5% to 73.5 (autoclaved) and 75.0% for raw sample respectively. Fat content of heat treate chicken meat samples showed low values when compared to the raw sampl That of autoclaved samples ranged fro 0.5% to 2.0% while that of the ra samples was 2.5%. The ash content the autoclaved chicken meat sample were higher in values that the raw samp in the range of 1.20% to 1.62 (autoclaved) and 1.02% for raw sample

Amino Acid Content

The results of free amino acid an mean essential amino acid contents a summarised in Tables 2 and respectively.

Effect of heat treatment on th free tryptophan content - related to th initial protein - in all the meat produc with the exception of canned po designated SA3 decresed relatively. Th decrease was approximately half of th initial quantity. The tryptophan value f SA3 (stationary autoclaved pork sampl was 0.80g while that of the raw samp was 1.40g. Example the tryptoph value for MA1 autoclaved beef samp was 0.54g while that of the raw samp was 0.64g; SA1 autoclaved pork samp 0.69g compared to the raw sample whi was 1.01g; CAI autoclaved chicken me sample 1.10g and raw sample 2.08g.

Some of the amino acids change significantly during heat treatment. F example glutamic acid in MA4 and MI autoclaved beef samples had 17.58g an 12.40g respectively while the raw samp had 5.62g; Threonine in SF2 autoclave pork sample had 56.50g while the ra sample had 4.14g; Asparagine autoclaved chicken sample CA1 h 12.28g while the raw sample had 10.18 With these, the decomposition reactio are usually fast at high temperature an method of heat treatment (stationary rotational).

The most important indicator of the resulting processes during heat treatment were changes of some amino acids when compared to the initial protein. In the first place the quantity of every single amino acid is important in the case of the products because these proteins or amino acids are cobined during consumption. However, in the case of ready cooked food the effective protein values is most important to human nutrition.

The best sources of essential amino acids from this study in order of quanlity among the canned beef, pork and chicken meat are summarized in table 4.

Data found in literature shows that moderate heat treatment of the meat generally increases the essential amino acid in small quantity calculated on the relative value of the protein, which because of expulsion of small ammonia with reference to crude protin explains the decrease in values (Vukov, 1981). Only long sustaining autoclave treatment caused decrease in the digestible amino acid content. On the other hand, with mild heating the free amino acid content also decreased.

Generally, the effect of different heat treatment used in this study were not strong enough in all products. There was no relative difference among the

Table 3: Mean Essential Amino Acid Content of Heat treated Canned Meat With Reference to its protein content

(g amino acid/100g protein)

Product Designation	Lysine	Theonine	Valine	Methionine+Cystine	Isoleucine	Leucine	Thyrosine+Phenilalanine	Tryptophan	Total
MA1	9.77	5.92	3.48	2.54	3.19	6.66	6.25	0.54	38.35
MF2	9.66	7.75	3.07	2.39	2.61	8.25	6.75	0.61	39.10
MA3	8.88	5.31	3.32	2.38	2.85	6.69	6.31	8.86	36.60
MA4	9.0	6.23	2.95	2.40	2.92	7.99	6.45	0.63	38.57
MF5	11.32	6.12	3.64	4.10	3.36	5.59	7.57	0.59	43.29

Table 3: Continued

Product Designation	Lysine	Theonine	Valine	Methionine+Cystine	Isoleucine	Leucine	Thyrosine+Phenilalanine	Tryptophan	Total
SA1	10.60	4.44	4.02	5.47	3.26	7.46	7.42	0.64	43.31
SF2	9.73	6.50	4.74	3.14	1.83	6.60	7.24	0.68	40.46
SA3	8.52	7.09	5.49	3.61	2.61	6.73	7.55	0.80	42.39
SA4	8.95	5.26	4.05	4.90	3.95	6.11	6.22	1.28	40.72
SF5	8.94	6.14	5.99	3.46	2.29	6.63	6.05	0.87	40.37
CA1	10.61	5.85	4.02	4.35	3.40	7.12	7.58	1.10	44.03
CF2	10.63	5.88	4.07	4.65	4.20	6.80	7.91	1.19	45.33
CA3	10.10	5.96	3.66	4.80	4.09	6.18	7.55	1.32	43.66
CA4	9.86	4.91	3.77	3.87	3.37	6.83	7.89	1.45	41.92
CF5	10.01	5.81	4.27	4.65	3.49	6.63	7.48	1.24	43.60

Table 4: Best Sources of Essential Amono acid in order of quantity among canned beef, pork and chicken meat

	Lys	Thr	Val	Met+Cys	Ile	Leu	Ty + + Phe	Try
Products' Symbol	MF5	MA4	MF5	MF5	MF5	MF2	MF5	MA3
	SA1	SA3	SF5	SA1	SA4	SA1	SA3	SA4
	CF2	CA3	CF3	CA3	CA1	CF2	CA4	

Table 5: Thiamine Content of Different Canned Meat

(mg/kg/meat)

Product Designation	Thiamine Content	Product Designation	Thiamine Content	Production Designation	Thiamine Content
M	1.86	S	19	C	1.25
MA1	1.13	SA1	0.44	CA1	0.06
MF2	1.20	SF2	0.58	CF2	0.13
M	1.99	S	1.33	CA3	0.09
MA3	1.03	SA3	0.81	CA4	0.10
M	2.50	S	1.80	CF5	0.10
MA4	0.90	SA4	0.61		
MF5	0.85	SF5	0.68		

canned beef. In the case of canned chicken, glutamic acid and lysine showed relative difference, to be more precise lower temperature favoured their retention. With regards to the pork sample, both temperature and rotation of the cans, isoleucine showed relative differences. According to the results in table 2, heat treatment of stationary cans and at higher temperature (125°C) more amino acids were retained.

Thiamine Content:

According to the results (Table 5) the beef samples were more able to withstand the different processes of heat treatment. The thiamine content of canned beef were higher than that of the other canned meat. The canned beef designated MF2 showed the highest quantity (1.20mg) and MF5 showed the lowest (0.85mg). Thiamine retention in the case of rotating heat treatment was not always favourable with canned beef.

Thiamine retention was higher in canned pork in rotating heat treatment than with stationary heat treatment. The highest thiamine content among the canned pork was found in SA3 and the lowest was in SA1.

In the case of canned pork more thiamine was retained in rotating than with stationary heat treatments. The highest thiamine content among the canned pork was found in SA3 (0.81mg) and the lowest was in SA1 (0.44mg). The autoclaved chicken meat samples contained the lowest quantity of thiamine when compared to the non-heat treated samples. The thiamine of the canned chicken meat were more sensitive to the heat treatment than the other canned meat. Among the cans of chicken meat samples, the one designated CF2 heat treated in rotating position at 115°C contained the highest value (0.13) while CA1 sample autoclaved in stationary position contained the lowest value of thiamine (0.06mg).

CONCLUSION AND RECOMMENDATION

The prepared sample of canned meat contained relatively little of their own juice, so that sterilization of such canned meat can occur with stationary heat treatment and the heat spread is mainly by conduction.

The traditional heat treatment in stationary cans occur at a temperature of approximately 125°C. The protein, thiamine and other valuable material contents were not substantially destroyed. At a temperature lower than this (115°C) - with the exception of pork with longer time heat treatment in stationary cans, higher heat destruction of the product is likely.

Consequently, from the aspect of quality, optimal technology of heat treatment can be considered as (with foods heated mainly by conduction) where the above conditions are realized.

On these basis and in accordance with these experimental results, the introduction of this technology of stationary sterilization of such and similar characteristic products at 115°C and 125°C is recommended.

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