Influence of thermal processing by steam convector of the pickled game meat

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Abstract

Introduction. The aim of researches was a rationale of possibility of the use of different methods of thermal processing in technology of the pickled ready-to-cook foods from wild game meat and determination of its optimal regimes.

Materials and methods. Technology of thermal processing of the pickled ready-to cook product, meat of wild boar, marinades, barbecue is investigated after use of the different methods of thermal processing. For determination of content of iron the sulfosalicylic method of determination of oxide of iron is used, and for determination of the content of zinc is used inverse voltamperometric method. The method of determination of infra-red spectrums with the help of device of "Infrapid" is used.

Results. The food value of meat of wild animals was estimated by physical and chemical indexes. It is set that on physical and chemical indexes meat of wild animals doesn't yields to meat of agricultural animals – pork and beef, but prevail in content of albumen on 2,9–6,8%.

It's proven on that amino acid composition of meat of wild wild boar does not yield to pork, and by such amino acids, as a valine, isoleucine, leucine, threonine and tryptophane considerably prevails it. Also it prevails pork by the total amount of irreplaceable and replaceable amino acids on 2,45 and 0,81 g/100 g of protein accordingly, and its albuminous quality index is higher on 0,35 g/100 g.

The comparative estimation of influence of different methods of thermal treatment on the output of barbecue educed advantages of the use of steam convector and microwave owen compared with traditional frying and steaming. Decline of losses of content of moisture in the finished product on 23% after processing in steam convector serves as reason of increase of output of barbecue.

Preparations of foods in steam convector were carried out due to the convection of hot air which was created by heating of electric tubular heaters or gas. Permanent circulation of hot air provided the even baking of foods in stoves and speed of their preparation. In steam convector sprayer system of moistening is set, that is why humidity of air was in a working chamber was regulated.

Conclusions. The recomended technological mode for preparing of barbecue in steam converter is: t=220-260 °C, φ=15% for 9 minutes. Mineral composition of meat of wild boar surpass meat of pork by maintenance of some micro- and macronutrients. High maintenance of iron – 1500 mcg/100 g in meat of wild boar – is able to satisfy the 20% of daytime ration of man.

Introduction

Thermal processing is a basic reception in the technological process of production of meat products. Mostly it is used on the finishing stage of cooking and is used with the aim of leading the product to the culinary ready condition, and also elimination of potentially toxic microorganisms (due to D.I.Lobanov) [1].

There are many receptions of thermal processing in technology, but in basis there are two methods – moist and dry heating . Therefore roasting and boiling are considered as the basic methods of thermal processing, and other methods are the variety of basic ones. In technology of dietary products most application was found by the moist heating. Boiling of foods is possible in great number of liquids, in a few amount of liquid or in its' own juice and on a steam [2]. In some cases foods are processed at a mionectic temperature (on water bath), at excessive pressure (in autoclaves) and at mionectic pressure (in vacuum pans). Large interest, from the point of view of the use for preparation of dietary foods presents heating in the field microwave radiation because the foods which are coocked by this method, by the organoleptic properties approach to ones that were treated in water environment (A.F.Maliutyn; H.N.Lovacheva, A.I.Mglinets) [3].

With the aim of intensification of process of thermal processing of foods by a steam can be applied such varieties of this heating : treatment the overheated steam, at excessive pressure, with a force convection [1].

Due to researches the advantages of heating of the overheated steam were educed as compared to traditional methods. M.A. Husman marks that duration of thermal processing of ready-to-cook foods in vehicles with the overheated steam are reduced, as compared to heating in SHK-2A, on a 20% and output of the prepared product increases no less than 10% with high organoleptic properties. Data which were got by Beloborodov V. and Khudov V. testify to reduction of process of heating of different products by the overheated steam (at pressure 2,06*105 Pascal) on 50-210% comparing to boiling in water [2].

Acceleration of process of processing of foods by using steam it is possible to attain by heating at exessive pressure. During the increase of temperature on the surface of samples (in comparing to heating at ordinary terms) there is a greater gradient of temperature between layers, that creates more intensive heat-and-mass transfer into a product and stipulates reduction of process of treatment of products. Heating at excessive pressure is widely used in a thermal equipment that is produced abroad by different firms [4].

Realization of principle of a force convection of coolant-moderator also can assist intensification of heating of foods by moist saturated steam (at atmospheric pressure) [5].

However an unambigiuous idea on this issue wasn't set. Researchers contradictory determine the degree of influence of speed of steam on the coefficient of heat emission and its' increase in comparing to the coefficient of heat emission, expected by Nusselt for a clean immobile steam [6].

Thus, at using of steam as a working environment in thermal vehicles it is necessary to aspire to achieve the maximal moving away of air from the swept capacity that will assist for the best heat exchange between a coolant-moderator and processed product. Heating with a force circulation of steam is used in steam converters that are produced in the USA and Germany [5].

It is known that than the lower temperature of thermal processing of meat products is, the greater outcome and the top quality of the product will be (A.A.Sokolov). That's why heating is recommended to conduct in the way, that a temperature across the entire thickness of product was near to minimally necessary (80°C). Observance of this condition during the thermal processing of the meat products can be attained by the use of heating of steam-air

mixture, the temperature of that lies in limits from 80 to 95°C. Experience of application of this method of heating in food industry for heat treatment of sausages testifies about its' efficiency [7].

As a number of authors (A.A. Sokolov; V.V. Karpov and other) reports, the row of advantages has boiling of foods by steam-air mixture as compared to other methods of heating (cooking in water, on a steam). The reduction of losses of mass, power charges, improvement of quality of sausage are one oj the methods [8].

Thus, the analysis of data of literature allows to make conclusion, that the use of heat treatment by steam-air mixture, by a steam at excessive pressure and with a force convection is perspective direction of improvement of technology of production of dietary ready-to-cook foods [5].

To most perspective types of universal thermal equipment belongs steam converter. The wide model row of steam converters is now presented from different producers that have different functional possibilities and price. They are divided by such rules : by the source of heating on electric and gas; by the method of creation and serve of steam on injector and boiler ones; on the method of management with an electromechanics and electronic management. Among the basic foreign producers are next firms: Rational SCC (Germany), Unox (Italy) and Abat PKA 10-1/1-P (Russia). Information about influence of the modes of thermal processing in steam converter on quality of the prepared meat products in particular small-sized and chopped ready-to-cook products are not enough. Zakharov A.A. notes the use of such devices on the catering enterprises, as intensity of heat-exchange processes rises, and also the losses of mass of meat foods (in 1,5 times) are redused in comparing to the traditional methods of thermal processing [4].

Nowadays there is a necessity for more detailed research of influence of thermal processing in steam-converter on quality of culinary products. Data which are got as a result of experiments will allow scientifically to ground the choice of the modes of thermal treatment of culinary products with the use of steam-converters [3].

Materials and methods

By material for research the meat of boar was selected; marinades; ready-to-cook foods after the different methods of thermal processing. In process the chemical and physical and chemical methods of researches were used. For determination of content of iron the sulfosalicylic method of determination of oxide of iron of Fe_2O_3 is used . Preparations of tests to the analysis were conducted by the method of dry mineralization. Two parallel tests are thus used and one control test is also used. A method is based on complete decomposition of organic substances by combustion of test of raw material in electric oven at controlled temperature [5].

Preparation of the sample to mineralization. Porcelain crucibles were washed, heated for hour at a temperature 80–90 °C in 1M solution of aquafortis, washed by the distilled water. Before the use porcelain crucibless burn out in a muffle stove [6].

From the prepared test took batch of 1–3 g ,and carried in porcelain crucible. Added 1–2 $см^3$ of 0,5M solution of hydroxide of natrium and 1–2 $см^3$ of 0,5M solution of nitrite of natrium. Thus a standard sample must not be moistened by solution. The crucible was covered by a lid and abandoned on 10–15 min at a room temperature, carried on a sand-bath that is located on electric oven and dried out carefully. Then crucibless were covered by a lid, carried in a muffle stove and maintained during one hour at a temperature 500 °C. The crucibles were cooled then. Mineralization is considered as completed, when an ash became

white or tinged color, without charry parts. At presence of charry parts treatment of ash solution by nitric acid solutiob of was repeated [5].

Preparation of the sample for determination. The content of crucible was placed in a volumetric flask of 100ml, with adding 5–10ml of a 25% solution of sulfosalicylic acid. In a retort added to the 25% solution of ammonia to appearance of weak smell. On the measure of neutralization of solution the pink-violet colouring passed to yellow. Surplus of ammonia does not influence on determination.

Led to solution in a retort the distilled water to the mark.

Construction of gauge chart. In volumetric flasks of 100 ml took away: 0,2; 0,5; 1,0; 1,5; 2,0; 2,5; 3,0; 4,0; 5,0 mg of the iron solution which was got earlier and took to the mark with distilled water.

Definition (photocolorimetric definition). The painted solution was poured in a cuvette and placed it in a right light stream. In the left cuvette of the same size was poured a "zero" solution that was prepared as follows.

In a volumetric flask of 250 ml capacity brought in 25 ml of a 25% solution of sulfosalicylic acid, conducted with the distilled water to 100ml and by drops added 25% solution of NH OH of the same concentration. Led the solution with distilled water to the mark and used for zeroizing of galvanometer.

Photocolorimetry was conducted with a blue colour filter.

Determinations of content of zinc were conducted using an inverse voltamperometric method with the use of analyzers of ABA- 1, ABA-2.

For verification of capacity of the measuring electrochemical system, readiness of operator to realization of this methodology, and also for audit of quality of base-line solution, cleanness of electrodes and cell a trial test was carried out .

Preparation of base-line solution. As base-line solution an acetate buffer is used, pH=4,6 0,1M that is got, mixing up 102 ml of 0,2-molar acetic acid and 98 ml of 0,2-molar solution of potassium acetate .

An acetic acid was cleared in bottletight desiccator, in the underbody of which was poured the concentrated acetic acid ,which was subject of cleaning, and on porcelain insert was put the quartz evaporated cup with the twice-distilled water by volume of 200ml. After 2–5 twenty-four hours a cup was reached, determined the closeness of the got solution of acetic acid on an aerometer. Distilled at that way acid was kept in a vessel from the polyethylene of high-pressure and use for preparation of buffer solution.

Preparation of redistillate. The distilled water was additionally out-distanced with alkaline solution of potassium manganate , periodically adding to the distillation retort of 2.3 ml of solution of otassium manganate to appearance of the pink colouring.

Preparation of potassium manganate .The solution of potassium manganate was prepared by dissolution of 10 g solid salt in 100ml of solution of caustic soda with concentration of 1moles/l (40g of caustic soda on 1 l of water).

Preparation of salt of gallium is from nitric acid salt of gallium. In a volumetric flask on 500ml brought in a batch of 1,999g of gallium nitrate, added 1,5 ml of HNO (2:3) and after dissolution of salt the solution was conducted by redistillate to the mark. The solution

had a concentration of ions of gallium on the level of 0,01moles/l. During the use of waterless nitrate of gallium the batch folded 1,279g.

Carrying out a trial test. The operating volume of cell was 10–25 ml.

The operating volume was filled by 10–25ml of solution of acetated buffer (pH=4,6) and added 1–2 drops of solution 10 g/l of Hg and 0,2-1,0 ml of solution of Ga (III) respectively. The cell was fixed in a holder, and made sure that auxiliary, basic and comparison electrodes are submerged in the solution.

Before the measuring we checked up the absence of break in the chain of "basic electrode-electrode of comparison" (for example, through appearance of air bubble), impermeability of insulating shell basic (indicatory electrode).

Control of impermeability was carry out in the next way: in prepared to work cell with the base-line solution inundated in it measured stationary potential of basic electrode in relation to the electrode of comparison. If impermeability of insulating shell is broken, then potential of basic electrode takes on a negative value instead of values of order from 0,15 to 0,4. Three cycles were conducted by measuring on the solution of background. As was mentioned higher, every cycle includes 4 stages: regeneration of electrode at potential 0.3-0.5 during 30.60 s, accumulation at potential – 1,3–1,45 during 30–300 s, acceleration of solution at the same potential – 1,3.-1,45 during 10–30 s [6].

Carrying out a basic test. After carrying out a trial test from cell was deleted solution of background and by a pipette brought portion of analysing solution a capacity even to the swept volume of cell and added solution to gallium (III) in an amount that provides 20-multiple surplus of ions of Ga (III) in relation to the concentration of ions of zinc in cell and 1-2 drops of solution 10 g/l of Hg (II).

The cell was fastened and the cycles of measuring led to 4 on this solution at the same electric modes and temporal intervals, similarly as for solution of background.

We entered addition of solution of comparison of zinc, the amount of that gets out so that the concentration of it in initial solution increased in 2 times. A volume of additive must not be large, not to do an error as a result of dilution of analysing solution.

The cycles of measuring conducted 3-4 times using the solution with additive.

Treatment with using the voltamperogram.

1. We identified the peak of measureable component (zinc), going out of the values of his potential of dissolution (-0,95B). Also a peak height was measured, by measuring of length of perpendicular from the top of peak on axis of potentials from a peak-point to the base-line line. A contribution was conducted in millimetres. If the different scales of registration of corn-floor are used, then the size of corn-floor is enumerated in microammeters.
2. We calculated the mean arithmetic value of peak height, casting aside the first value and, determining average from the next recreated heights of peak of corn-floor. An operator fixes in a working magazine the value of analytical signal and value of sizes which are necessary for a calculation.

h_1 – AV arithmetic values of height of peak of zinc in solution of background, mm or мкА;

h_2 – AV arithmetic values of height of peak of metal in solution of background, mm or мкА;

h_3 - AV arithmetic values of height of peak of metal in analysingsolution with addition of solution of comparison, mm or мкА;

V_x – volume of analysing solution, ml; C_1 – concentration of solution of comparison, mg/l; V_3 – volume of addition of solution ofcomparison, ml.

The size of concentration of ions of zinc in analysing solution (in mcg/l) was determined with the use of formula:

$$C_x = \frac{C_1 \times V_3 \times (h_1 - h_2)}{V_x \times (h_3 - h_1) + V_3 \times (h_3 - h_2)} \quad (1)$$

Methodology of research of infra-red spectrums of meat consists in the following: the samples of meat prepare preliminary,the pieces of meat are ground down with the help of meat cutter machines whereupon yield to drying in a drying closet at the temperature of 1500C to permanent mass, they are dried out then. The got dry powder is sifted on homogeneous sieves [3].

The farther sifted samples of meat are placed in cuvettes and make more compact.The process of determination of infra-red spectrums goes next with the help of "Infrapid", that gives an opportunity to conduct research in the interval of lengths of waves of 1330–2370 nanometers. On the finishing of determination of infra-red spectrums of meat the computer processing of the obtained data is conducted and the chart of spectrums of reflection is built.

Results and discussion

The amino acid composition of meat of wild boar was investigated. In a table 1 amino acid composition of meat of wild boar is given in comparing to pork.

By amino acid composition meat of wild boar does not yield to pork, and by such amino acids, as a valine, isoleucine, leucine, threonine and tryptophane considerably prevails it. Also it prevails pork by the total amount of irreplaceable and replaceable amino acids on 2,45 and 0,81 g/100 g of protein accordingly, and owns a higher albuminous quality index (correlation is a tryptophane/hydroxy-proline) that prevails pork on 0,35 g/100 g of protein.

In our work the infra-red spectrums of reflection were investigational in a near area. As objects the specially prepared samples of meat of venison, wild and domestic pork were used.

The feature of measuring of powdery samples was that all of them must have an identical degree of grinding with the next sifting on one sieve. Samples must be kept at equal terms. As an analyzer of infra-red spectrums the device of "Infrarapid", that gave an opportunity to conduct research in the interval of lengths of waves – 1330–2370 nm, was used.

Table 1

Amino acid composition of meat of wild boar in comparing with pork, g/100 of protein

Sample	Wild boar meat	Lean meat	Scale FAO / WHO, g/100 g of protein
Valine	4,81±0,23	4,74±0,25	5
Isoleucine	5,1±0,15	4,48±0,14	4
Leucinum	8,7±0,18	8,25±0,20	7
Lysin	7,82±0,32	8,07±0,34	5,5
Methionine	2,37±0,14	2,34±0,13	3,5
Threonine	5,56±0,13	4,36±0,18	4
Tryptophane	1,37±0,05	1,10±0,04	1
Phenylalanine	3,52±0,13	3,46±0,10	6
Totally	39,25	36,8	
Totally	46,29	45,48	-
Alanin	5,72±0,27	5,34±0,26	-
Arginine	6,52±0,35	6,67±0,31	-
Aspartic	7,81±0,22	7,45±0,23	-
Histidinum	1,57±0,06	1,49±0,04	-
Glycine	7,38±0,21	7,21±0,20	-
Glutamic acid	16,54±0,35	16,52±0,31	-
Hydroxy-proline	0,75±0,05	0,74±0,04	-
Correlation tryptophane/ hydroxy-proline	1,83	1,48	-

On the presented chart the brought spectrums of reflection of three powdery samples of meat of the above-mentioned animals. As we see from the Figure 1, all of them in a complete measure repeat each other for most stripes of reflection. But it's important to notice that reflective ability of samples is different. The spectrum of reflection of powder of meat of wild boar has the greatest reflective ability in this spectral range, and spectrum of reflection of powder from meat of venison – has the least reflective ability. The analysis of spectrums shows that inspite of the fact that chemical composition of standards obviously differs one from other, however in the spectrums of reflection in the investigated spectral region these differences do not appear. It is explained by the fact that it is necessary to prepare standards with the greater degree of growing shallow for the exposure of individual descriptions. In addition, on forming of spectrums considerable influence finds out humidity of standards, that constantly it follows to control in a process of measurement.

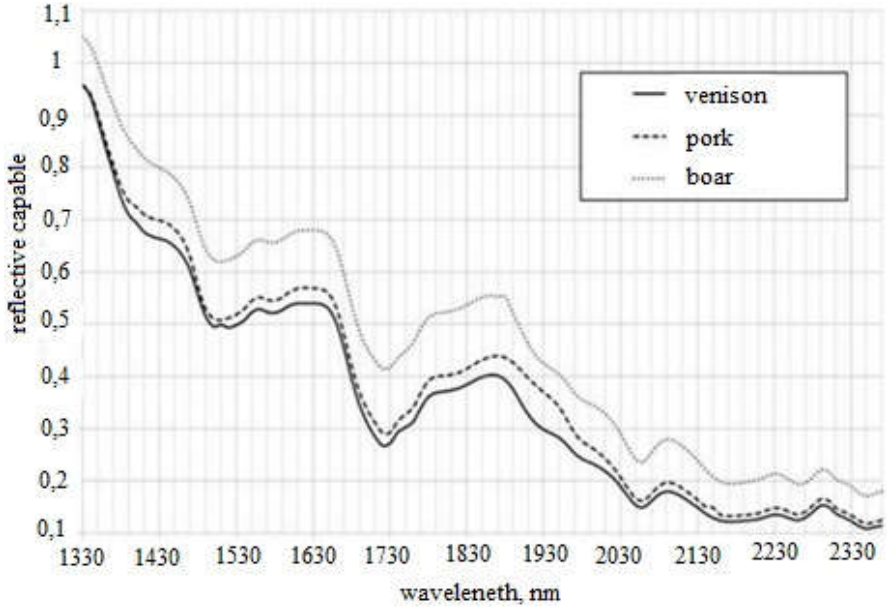

Figure 1. Spectrums of reflection of meat of different types of animals

Mineral composition of meat of wild boar surpass the meat of pork on maintenance of a row micro- and macronutrients. High maintenance of iron – 1500 mcg/100 g in meat of wild boar – is able to satisfy the amount close to the 20% of daily ration. This content of iron is also related to enhanceable maintenance in it to the myoglobin that is needed for more rapid motion of oxidizing processes for actively movable animals. High maintenance of iron influences on the color of meat of wild animals, giving to it more intensive crimson colouring in comparing with meat of agricultural animals.

The comparative estimation of influence of different methods of thermal treatment on the outcome of barbecue educed advantages of the use of steam converter and microwave radiation before traditional frying and processing on a steam. Decline of losses of content of moisture in the prepared product after processing in steam converter serves as reason of increase of outcome of barbecue. Also there is reduction of losses of mass of ready-to-cook foods at microwave radiation heating in comparison with frying.

The increase of outcome of finished products at thermal processing in steam converter is explained, by more moderate temperature conditions of heating of samples, than in a traditional method. It causes less deep physical and chemical changes at albuminous system of products, that results in reduction of losses of mass. By a significant index that characterizes the change of mass of meat products during thermal treatment, their succulence and consistency we mean is water-binding capacity. Property of meat products to hold moisture during heating depends on content in them the adsorption-bound water, so as a loss of moisture during thermal treatment is related mainly to the selection of weakly bound water, as the adsorption is more firmly contained by the polar groups of proteins of meat. But during the heating of foods part of the adsorption-bound moisture diminishes however, as a result there is side-shifting of equilibrium to increasing of content ofweakly bound moisture that results in the change of water-binding capacity.

Table 2

Loss of mass and water-binding capacity of finished product after thermal treatment in different ways

Thermal treatment method	Outcome, %	Losses, %	WBC_a, %	WBC_m, %	pH
Frying	50,0±1,2	50,0	55,3±1,8	23,4±0,9	5,7±0,09
Microwave radiation heating	54,2±0,9	45,8	66,8±1,7	26,34±1,2	5,55±0,04
Processing with the help of steam	51,2±1,6	48,8	58,7±1,5	25,3±0,7	5,75±0,07
Processing in steam converter	68,0±0,75	32,0	75,0±1,2	49,7±1,4	5,65±0,03

The data that are given in the table 2 specify on the differences of WBC of the prepared product treated by the investigated methods. The best indexes are marked at microwave radiation heating and at processing in steam converter, other methods of thermal processing do not result in the substantial increase of WBC.

The changes of mass at thermal treatment of meat products are related mainly with the losses of moisture, water soluble organic and mineral substances and predefined by a high temperature that causes denaturation of albuminous substances and substantial reduction to water holding capacity.

Potentiometric determination of active acidity of the prepared samples did not educe noticeable differences in the dynamics of this index depending on the applied method of thermal treatment of product.

Reductions of losses of mass, increase of WBC result in the improvement of tenderness and succulence of the finished product.

Preparation of foods in steam converter comes true due to the convection of hot air which was formed due to heating of electric tubular heaters or gas. Permanent circulation of hot air provides the equable baking of foods in stoves and speed of their preparation. In steam converter sprayers system of moistening is set, that is why humidity of air in a working chamber is able to be managed.

In a table 3 these researches over of barbecue are given which was prepared by thermal processing in steam converter at the different modes.

Table 3

Comparative description of functionally-technological properties of barbecue from game meat during processing at the different modes

Temperature of processing	Outcome, %	Losses, %	WBC_a, %	WBC_m, %	pH
220^0C	67,1±1,1	32,9	67,9±1,1	55,0±1,1	5,6±0,08
240^0C	69,0±0,5	31,0	68,9±0,4	54,1±0,4	5,65±0,05
260^0C	61,5±1,2	38,5	59,7±0,9	35,8±1,2	5,7±0,09

Analysing these dates of tables 3, the method of thermal processing of barbecue was recommended in steam converter for the temperatures of 240℃, both functionally-technological indexes and organoleptical estimation of the investigated foods were taken into account.

Conclusions

1. The infra-red spectrums of reflection of meat of wild boar, pork and venison showed in a near area, that the spectrum of reflection of powder of meat of wild boar had the greatest reflective ability, and spectrum of reflection of venison – the least, in spite of the fact that chemical composition of standards differs one from other.
2. The technological mode is recommended for processing of barbecue in steam converter by t=220-260℃, φ=15 during 9 minutes
3. Mineral composition of meat of wild boar excels meat of pork on maintenance a row micro- and macronutrients. High maintenance of iron – 1500 mcg/100 g in meat of wild boar – is able to satisfy to the 20% of daily ration.

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