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PHYSICO-CHEMICAL AND TECHNOLOGICAL ASPECTS OF PASTERMA PRODUCTION

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BACKGROUND: Pasterma is salted and dried beef and is one of the various types of dry cured raw meat products. The decrease of the water activity by the addition of sodium chloride and by drying prevents the development of undesired microorganisms. Thus the meat product becomes stable. Because of their medium moisture content such products are described as **Intermediate Moisture Foods** (IMF). Their manufacture is based on the hurdle technology (BRIMELOW, 1985). The microbial stability of the IMF-pasterma product is reached by two hurdle effects: a_w and nitrite. It is a typical product of the eastern Mediterranean countries (BERKMEN, 1960; AWAD et al., 1972). In recent years pasterma was distributed nearly all over the world. Technological changes, based on differences of the groups of consumers, led to risks due to stability and quality of this product (GENIGEORGIS et al., 1984; EL-KHATEIB et al., 1987).

OBJECTIVE: The quality traits of pasterma were to be optimized in order to increase the safety of the production at the same time. The influence of some technological factors such as salt concentration, nitrate, starter microorganisms and pressure was investigated. The physical and chemical changes during the production process were measured.

METHODS: The pasterma was produced from beef M. longissimus dorsi, cut off bones, sinews and fat. The manufacture was based on data published by BERKMEN (1969) and given by KARAIOANNOGLOU (1994, personal information). The cuts weighed 1.5 to 2.0 kg, they were 20-30 cm long, 10-15 cm wide and 5-8 cm thick. The meat pieces were rubbed with a mixture of sodium chloride, nitrate and sugar, and were then cured in stainless steel containers at 4-6 °C for 8-12 days. They were turned over twice in their own brine formed by the exudated meat juice. After salting the meat was washed and hung up seperately, i.e. not coming into contact with each other. This procedure was followed by drying at 12-14 °C, at a relative humidity (rh) of 80-85 % for 2 days. The drying process was continued for 4-6 days at 14-16 °C and a rh of 75-80 %. During this second drying period the salted meat was pressed several times for 24 hours using weights (50 kg) or a mechanical press. The pieces were piled up in several layers, separated by clean clothings absorbing the exudated meat juice. When the salted, dried and pressed meat cuts reached a water content about 45 %, their whole surface was pasted with a garlic paste layer of 2-3 mm. The paste consisted of fresh, chopped garlic (34 %), ground seeds of fenugreek (chimen;Trigonella foenum graecum, 20 %), hot pepper (6.5 %), ground coriander (1.5 %) and 35 % water. The pasted pasterma was dried at 12-14 °C, at a rh of 75 % and with good ventilation for 6-8 days. Two trials were carried out, which only differed in the added amount of salt and in the pressing method. With the **first trial** two different starters were added: a mixture from *L. curvatus* and *Staph.. carnosus* (Mixture 13, Fa. R. Müller, Gießen, Germany) and a *M. varians* strain from Bulgaria. The suspensions contained 2.25×10^7 cells/ml for the mixture and 1.0×10^7 cells/ml for the Micrococcus strain. 2 % (vol/wt) of the suspension was inoculated into the meat at different locations with a pickle syringe (Fa. Dick, Germany) before curing. The control batch remained untreated. After that the three batches were salted with 15 % NaCl. Apart from this 0.25 % saccharose, 0.25 % glucose and 0.04 % KNO_3 were added. The following treatment has been described above. With the first trial high salt concentrations were applied according to traditional technologies of pasterma production. However, today meat products with a low salt content seem to be preferred for two reasons: sensory acceptance and health (hypertension). In such cases the stability of the products can only be maintained, if the lowered salt addition is combined with other hurdles (e.g. nitrite, drying, starter bacteria). In the **second trial** the amount of added sodium chloride was reduced to 5 % and the meat was not washed after the salting period. The application of the starters was equal to the first trial. To make the growth of undesired bacteria more difficult, the temperature during the first drying step was reduced to 10-12 °C; rh was adjusted to 74 %. The meat pieces were pressed by a mechanical press, which allowed the application of a much higher pressure than could be reached by weights. The drip loss was enhanced distinctively. The other steps of the technological process remained the same as with trial one. With all batches samples were taken from the raw material (A), after curing and washing (B), after drying (C) and from the final product (D). The determination of the physical and chemical parameters, such as pH and a_w, weight loss, protein, fat, water and ash, NaCl, colour and firmness were done as by KATSARAS and PEETZ (1994). The sensory evaluation was made by a 9 member panel using a 6-point scale: 6= very good; 1=not acceptable.

RESULTS and DISCUSSION: With the **first trial** the effect of suitable starter bacteria on the quality, especially on the physico-chemical properties of pasterma should be investigated. For this purpose three batches of pasterma were manufactured: control I without starters, group II with *L. curvatus* and *Staph. carnosus*, group III with *M. varians*, only. The **pH-values** of the control I and batch III increased during manufacture by 0.2 units. The highest value of a final product was 5.89. Group II had the lowest pH (5.63) after curing. Here the influence of the lactic acid formation of *L.curvatus* seems to be obvious. At the end of the process no significant differences due to pH could be found between the products of the three groups. The highest decrease of a_w, which was caused by NaCl and water loss,was measured after drying. The pasted products showed slightly increased a_w-values (0.01 to 0.07 units) compared to the dried samples. It is assumed, that the water containing paste first increases the water activity of the meat pieces and then it retards further evaporation of water from the meat surface. According to the expectations the **protein** content of the pasterma increased during the whole process because of the water loss. The **water** content showed an almost linear decrease, but there were considerable differences between the three groups. The samples of group II inoculated with *L.curvatus* and *Staph.carnosus* had the lowest water content. The difference between control and batch III with *M.varians* were not significant. In the course of pasterma manufacture a considerable increase of **sodium chloride** (fig.1) was analysed with all batches. At the end of pasterma production the salt concentration in the meat reached a maximum of 14.8 % (group II) and 10.4 % (group III).

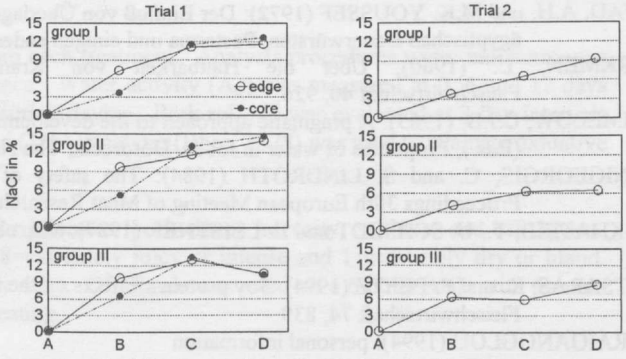

Fig. 1: Development of the sodium chloride content in pasterma

Such concentrations are not usual to be accepted by the consumer. Although these amounts of salt were accompanied by high amounts of nitrate and nitrite, the concentrations of **nitrosamines** formed could be considered as very low. The **firmness** showed a general increase during the pasterma manufacture. Slight differences -control batch I had been firmer than groups II and III- are caused by variations in raw meat quality. With the **colour** determination it was shown, that the L*-value (brightness) decreased distinctively during salting and drying. A similar tendency was observed with a*- and b*-values. The red portion (a*) of group III had been more intense than that of the other groups. This better development of cured colour was a result of extensive nitrate reduction. Group III showed the best colour traits of all. From the **sensorical point of view** the overall appearance of all products was regarded as well. At the cuts differences in colour were found. The sensory panel evaluated the control I with 3.9, group II with the starter mixture with 4.7 and group III (*M.varians*) with 5.7 points. The texture of all tested products was considered similar. Because of the high salt content of all batches almost no differences could be found with regard to taste and flavour. Generally, group III was evaluated better than the other groups.

The traditional technological procedures with trial one led to products with excessive salt concentrations, which were necessary to reach the desired decrease of the water activity. The **second trial** was aimed at the decrease of the water activity by adding a lower amount of NaCl (5 %) together with the application of a suitable pressing equipment. The evaluation of the products was also based on physico-chemical determinations. Especially with batch II (*L.curvatus* and *Staph.carnosus*) the **pH** decreased during the salting period. After drying an increase of the pH-values could be found in all groups, but to a different extent. The highest values were measured in the final products of the control batch; group II and III showed similar ones. The **water activity** decreased with all batches to the same degree. The a_w-depression was sufficient to prevent the development of undesired microorganisms. The maximum increase of the **protein** portion (14-15 %) took place during the drying process. In the final product of group III with *M.varians* a somewhat higher protein content was analysed. The **water content** of all products decreased steadily during manufacture. At the end of the process 40.5 % (batch III), 45.1 % (batch II) and 42.1 % (control) were determined. The addition of 5 % **sodium chloride** with trial two led to a lower salt content compared with trial one. The following concentrations were analysed in the pasterma products: 9.2 % in the control group (highest value), 6.4 % in group II and 8.6 % in group III. The salty taste of pasterma is considered moderate at concentrations between 4 and 6 %. In the context it should be mentioned, that the sensory acceptance of salt is dependent on the water content of a meat product. Higher salt concentrations are accepted with strongly dried products. Due to the **firmness** of the pasterma differences were observed between the batches. All groups showed a discontinuous increase of firmness. The final product of group III reached the same level of firmness as the control product. Group II yielded the highest firmness. This means, that not only the loss of water, but also the constitution of the meat are responsible for the texture properties of a pasterma. The periodical application of a high mechanical pressure to the meat pieces was proved to be an important factor for the acceleration of the dehydration process. In this way **weight loss** (fig.2) and texture formation were forced to an extent, that they remained constant after finishing the drying step. The development of the **colour** parameters (L*, a*, b*) took the same course as with trial one. L*-values decreased steadily with group III reaching the lowest level. The changes of a* and b* of all groups followed the same pattern as L* did. The final pasterma products of the starter batches had higher a*-values than the control, i.e. they had a more pronounced red portion (fig.3). From the **sensorical point of view** the overall appearance of all products was estimated well. Differences between the three batches were found with respect to the cured colour formation. The samples inoculated with starter microorganisms got the best evaluation. On the whole the panelists preferred group III (*M.varians*) due to its palatability, colour and tenderness.

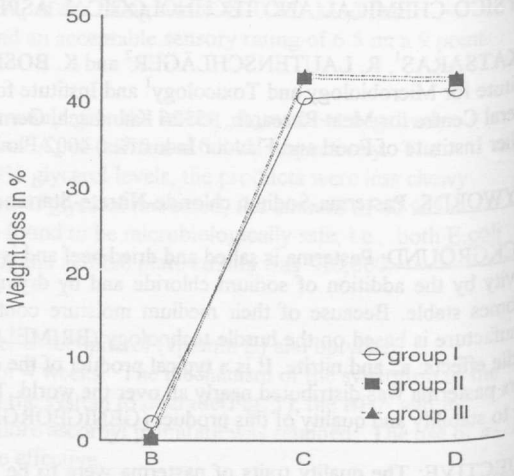

Fig. 2: Weight loss during pasterma production (trial 2)

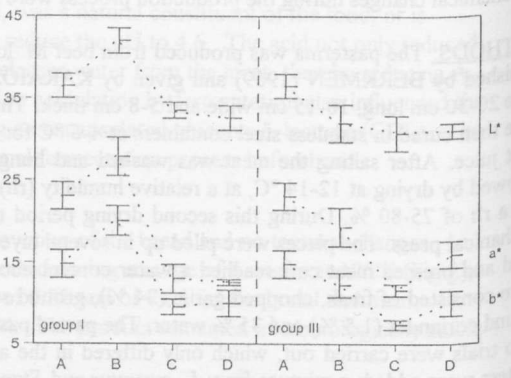

Fig. 3: Development of the L, a, b values during the phases of the pasterma production

CONCLUSION: The use of starter bacteria had a favourable effect on the quality of pasterma. The lactic acid bacteria accelerated the decrease of the pH-value and thus they improved the texture formation of the pasterma. *M. varians* reduced nitrate to a remarkable extent to nitrite, which led to a better cured colour formation. For the manufacture of pasterma with a low amount of sodium chloride the application of starter bacteria as well as a mechanical pressing procedure are required to guarantee a shelf stable product.

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