A C T A A L I M E N T A R I A P O L O N I C A
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MEAT PROCESSING UNDER LIMITED ENERGY SUPPLY

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The main energy economissing effect can be reached by full utilization of slaughter animal raw material because of an energy consuming share of 97% by primary production of animals in agriculture. Further effects result from strickt controlling of thermal parameters, using non-thermal procedures for preservation, avoiding thermal round about ways in processing. Biotechnological biomass production will be able to substitute meat protein by a very low energy consuming procedure.

INTRODUCTION

In a plenary session it is quite usual to give a review on the field which is included by the headline given. This is necessary but I'll do it in very short terms in order to concentrate my efforts on more "preview".

Energy has a lot of forms such as chemical, thermal, mechanical, electrical and that of radiation for instance. These forms are closely connected together and sometimes we forget this connection and have an approach too specialized for instance on thermal or electric energy, if industrial processes are discussed. Following the complex characteristics of energetical points of view in meat I propose to you the items as below: meat processing under limited energy supply. Main principles

— low waste procedures,
— precise process control,
— natural preservation,
— avoiding thermal roundabouts,
— using biotechnical protein sources.

Before going in details it would be interesting to give an overview about general relations in this field as you see in Table. The relative importance of single problems becomes clear by these figures.

Table. Energy in meat industry

$$\eta = 0.2 \left(= \frac{\text{incorporated nutritional energy}}{\text{agricultural and industrial energy efforts}} \right)$$

for slaughter	40-50%
for cutting and processing	30-40%
for waste treatment	20%
totally for heating and cooling	85%
processing energy of total energy efforts	3%

LOW WASTE PROCEDURES

The high energetic value incorporated in the meat itself, the high transformation losses between fodder plant energy and animal carcase of about 80% are stimulating us to use the raw material as carefully as possible. This is a matter of main interest [7].

So the example of the Convex-procedure [3] in which meat, which has been remaining at bones and parts of carcasses is yielded in a nutritional quality for sausage production, ready dishes a.s.o. should be widespread more extensively in order to maintain an important source of food protein. Concerning blood we know, that only 20% of the protein are contained in the plasma which is rather often used but not everywhere. The shaped particles representing 80% of the protein have an intensive color which hampers a wide use. Finnish and japanese experts found a way decolouration with help of CMC [15]. This opens a way of utilization the whole blood protein content. By hydrolizing red blood particles with adequate enzymes it could be thinkable to obtain colourless protein solutions.

Emulsion made from fat and blood are to be used for sausage production as a white and creamy component. The dutch colleage Pardekooper [11] found an interesting relation between net power consumption of bowl choppers during the process and structure formation in the meat batter, see Fig. 1. Derived from this curve it would be interesting to try to develope an automatic device which controls the water addition during the process according to the real and actual water binding capacity. This could result in the maximum yield which is reachable and possible from the sensory point of view too [12].

PRECISE PROCESS CONTROL

More sophisticated measurement, modelling of processes and computer control will enable us to realises a more precise process control. This brings the benefit of raised yield and diminished energy consumption ad the following examples will show [14].

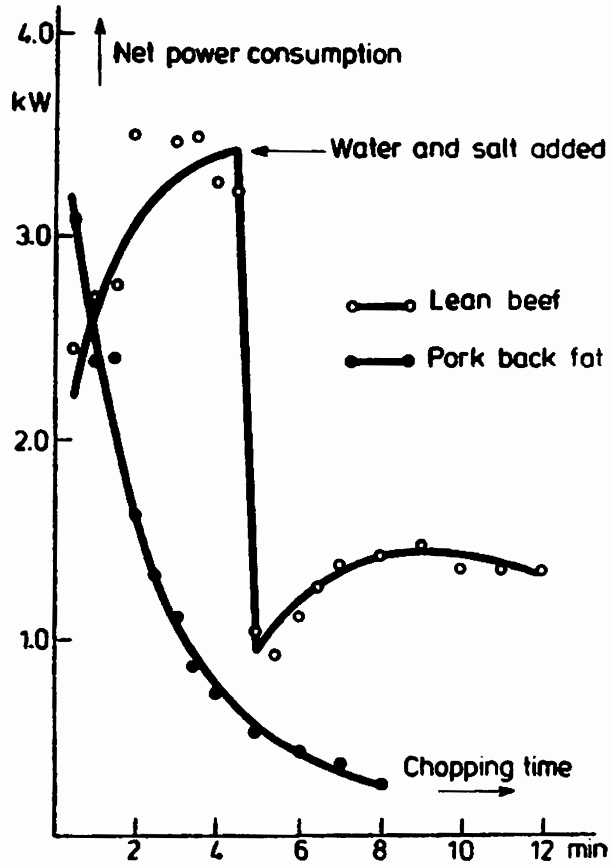

Fig. 1. The net power consumption (kW) by a bowl chopper as a function of the chopping time for two raw materials

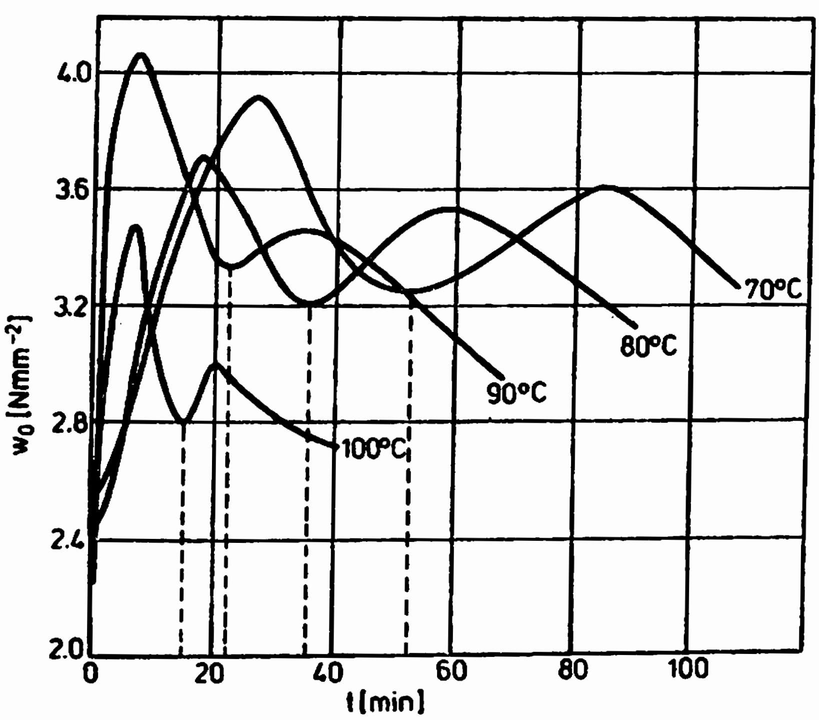

Fig. 2. The influence of cooking temperature and of cooking time on the specific strain energy due to distortion according to Wolodkiewitsch on the example of *M. longissimus* of pork (texture effect)

The $\triangle$ T-procedure in cooking of minced meat products like sausage, patties and other rather homogenous products gives a high reliability on using programmed procedures with regard to the actual core temperature [13].

For whole meat this approach ist unsufficient, because its qualities are changing in a wide range and besides this it is never homogeneous. As we found out there are characteristics curves of shear rates depending from process time as Fig. 2 shows. The first firmness minimum is the point at which cooking process

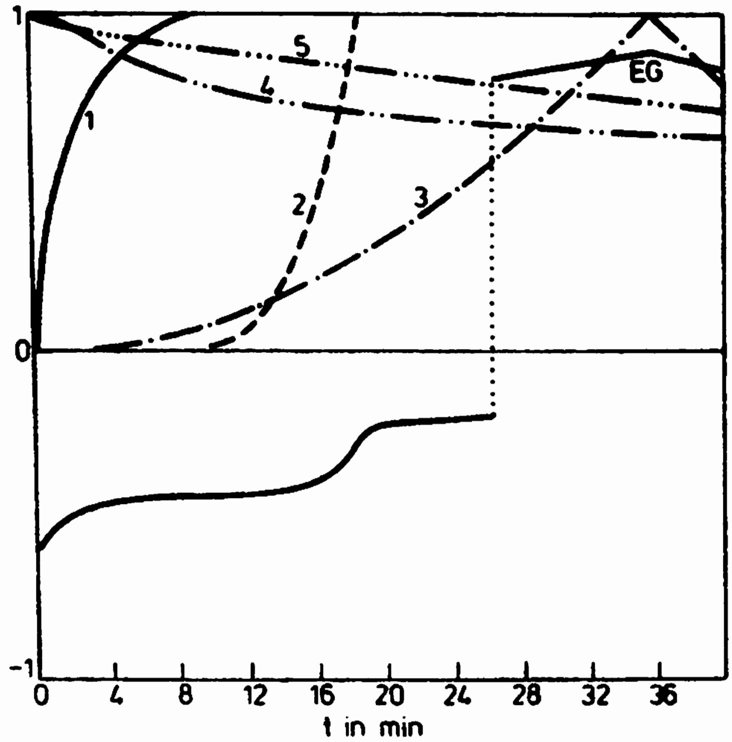

Fig. 3. 1 — core temperature, 2 — pasteurization effect within the core, 3 — cooking time, 4 — mass defect, 5 — total energetical efficiency

should be finished in order to maximise tendernes and to minimize energy demand, mass losses and time required for the process [10]. Fig. 3 demonstrates like this term influences the whole result, named "effectiveness grade" in an essential manner.

Using computers for receipe optimization by a manyfold soft ware we economise a lot of raw material, energy and time. There is a raising number of solutions [2]. Fast cooling procedures beginning at temperatures below 0°C can economise some meat mass if there is an accurate core and medium temperature control. A carefully controlled enzymatic process for tenderizing meat can help to obtain high quality and high yield products.

NATURAL PRESERVATION METHODS

Ancient traditions expecially from Asia teach us how to preserve food products like meat without modern energy demanding methods like cooling, freezing or sterilizing. The so named "barrier concept" which is formed by low pH, high dry matter content, little heating, little radiation allows a long life time of products without measures of further technological action. This concept should be utilized more consequently in the daily product development.

The action of starter cultures as in the early 1950ies investigated by Niinivaara [9] and now fully adopted as a means of biotechnology supports such a concept by lowering the pH.

The irradiation of foodstuffs by rays from nuclear sources is another principle for maintaining food quality over a long period. This procedure is allowed to use in some countries (like in the GDR), in others the struggle for admittion is going on. Using a limited intensity of radiation there are no sensory dewiations — and besides this the process is very productive and the energy demand is so low.

AVOIDING THERMAL ROUNDABOUTS

Often we find rather complicated cycles of rapeated chilling, freezing, thawing, cooling, chilling and so on, see Fig. 4. These thermal roundabouts are sometimes avoidable, sometimes necessary. It so should be a duty for all technologists to analyse their processes, to find new fundamental approaches to avoid the irreversible losses caused by the so named thermal roundabouts [1].

Hot boning of meat is one prominent example of such an approach. Naturally we know very well that here not only thermal reasons but in addition to it such of technology, quality and management [5].

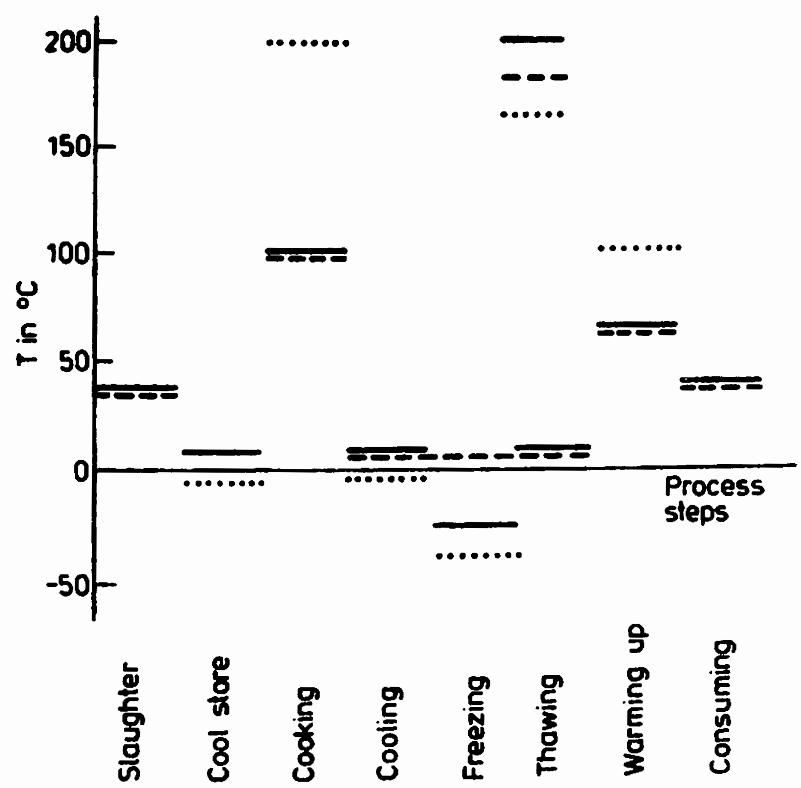

Fig. 4. ——— T_{core}, – – – $T_{core,\ alt}$, ··· T_{medium}

USING BIOTECHNICAL PROTEIN SOURCES

Yeast and bacteria are delivering proteins in a much cheaper way then cattle and swine do. The overall energy demand for single cell protein production is very low. Unfortunately hydrolization and purification procedures mostly are necessary in order to reach nutritional qualities. World wide a lot of problems are under research work including genetic engineering methods [4].

A rather elegant way is the cultivation of mockstock with meat like texture, a procedure which minimizes the number of process steps and with it the energy demand [6].

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PRZERÓB MIĘSA PRZY OGRANICZONEJ PODAŻY ENERGII

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Streszczenie

Główny efekt oszczędności energii w przemyśle mięsnym może być osiągnięty przy pełnym wykorzystaniu surowców rzeźnych; udział zużycia energii na wyprodukowanie żywca rzeźnego wynosi bowiem 97%. Dalsze oszczędności energii mogą być uzyskane przez ścisłą kontrolę parametrów procesów termicznych, unikanie niepotrzebnych energochłonnych naprzemiennych procesów termicznych (jak zamrażanie, rozmrażanie, obróbka cieplna i ponowne zamrażanie), jak również zastosowanie innych, poza termicznymi, procesów utrwalania mięsa (realizacja „koncepcji barierowej", wykorzystanie bakteryjnych kultur starterowych i innych procesów biotechnologicznych, utrwalanie radiacyjne).

Generalnie produkcja białka mięsnego jest jednak wysoce energochłonna. Produkcja biomasy białkowej metodą bakteriologiczną pozwoli zastąpić białko mięsa przy bardzo niskim relatywnie nakładzie energii.