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ECONOMIC IMPLICATIONS OF HOT MEAT PROCESSING

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In the model system study it was estimated that the refrigerated space to chill the edible portion of carcasses is approximately 30% of that required to cool conventionelly hanging sides and processed meat products. The energy requirements to cool meat and meat might be reduced approximately by 50% after introduction of hot processing.

INTRODUCTION

Growing costs and dwindling fuel resources, especially in the meat industry, have increased the need for more efficient systems of processing meat. One of the potential ways of improving efficiency and conserving energy is hot processing. The advantages and disadvantages of this modern technology have been recognised by many authors [1, 2, 3]. Quality and quantity benefits which may occure from the accelerated pork and beef processing in most cases were demonstrated under research conditions. But the extent of such benefits that may arise in the commercial practice is still an opened field of economical research. It is clear that hot boning prior to chilling saves energy by:

— chilling only the edible portion of the carcass,
— reducing the requirements for refrigeration facilities,
— reducing transportation cost,
— reducing needed labour.

It was shown in the model study of Harrington in Great Britain that in the case of completely new plant based on hot processing better return on capital can be obtained. Some commercial experiments in Great Britain and Zealand indicate that the refrigerated space required to chill hot boned cuts be reduced by 80 or even 90% [4]. This study was designed to evaluate the economic potential of accelerated pork and beef processing in a conventional plant with redesigned flow lines pattern.

METHODS

In the model systems, for both conventional and this based on hot processing, the same production programme was assumed. The programme is presented in Table 1.

The volume of products and their proportions resemble specification of the existing (conventional) plant. This should make the programme more reliable. To simplify calculations it was decided that there were no savings in yield or quality advantages from hot boning. Both model plants were designed to kill 300 cattle and 1300 hogs a day. Total capacity of each plant is more than 50.000 tons of fresh meats and meat

Table 1. Production programme of the model plants

Type of product	output kg/24 h	output kg/280 days
Wholesale and retail cuts	83 524.6	23 886 888.0
Fresh ground meats	3 742.0	1 047 760.0
M.R.E.	2 500.0	700 000.0
Cured meat products	57 595.0	16 126 600.0
— sausages:	38 324.2	
dry and semidry cooked — semistable cooked — unstable	1 080.4 8 388.0 28 874.4	
Processed variety meats	19 250.0	
Canned meats-pasteurized: — canned ham — canned shoulder	10 109.0 9 315.0 873.0	2 830 520.0
Canned meats-sterilized	16 983.7	4 755 436.0
Fats: Lard Inedible tallows	8 325.0 5 940.8 2 382.2	2 330 440.0
Total:	187 247.2	52 429 216.0

products annually on a single shift basis. Fresh meats — both pork and beef — are 45% of the total output of cutting and boning department. Trimmings designated for the manufacture of cured meat products and canned meats are approximately 18 and 8%, respectively.

In the plant with improved lay-out carcasses are killed and on the same day after slaughter and dressing operation they are hot boned, vacuum packed and cooled on trays to allow adequate air circulation. Shipping cooler has enough space to accomodate a whole day's kill. Trimmings are transfered to curing rooms. In the conventional plant fresh cold boned cuts are obtained on next day — from carcasses refrigerated immediately after slaughter on the first day. Cuts are packed into containers and despatched on either the same day or after being held overnight. It was assumed that meat cuts for canning are treated according to the usual (unchanged) technological rules.
Comparison of space and energy requirements for the model plants is presented in Table 2.

Under commercial conditions the temperatures of production departments, of carcasses, and of fresh meats products were measured. Corresponding temperatures for hot processing procedure were assumed on the basis of semi-commercial experiments. Energy was calculated according to formula:

$$Q = M \times t \times S_h$$

where:
M = weight of products kg/24 h
t = difference between initial and ultimate temperatures of meats °C
S_h — heat capacity (specific heat) $\frac{\mathrm{J}}{\mathrm{kg} \times {}^{\circ}\mathrm{C}}$

Losses of energy that are to be compensated by an additional energy input compiled:
— heat radiated by facilities (electronic motors etc.)
— heat of ventilation
— heat radiated by workers
— heat transmition of walls.

The measurements were made in the existing plant as well some data were obtained from the original technical documentation [5].

CONCLUSIONS

In the model system study it was estimated that:

1) the refrigated space to chill the edible portion of carcesses is approximately 30% of that required to cool conventionally hanging sides and processed meat products,

Table 2. Comparison of energy and space requirements for the two processing systems

Production area	Cold processing		Hot processing		Advantages (savings) and disadvantages of hot processing
	m²	%	m²	%	%
Total	8 200.1	100.0	8 200.1	100.0	—
Refrigerated area (below 5°C)	2 957.1	36.0	880.1	10.7	(+) 70.3
Air-conditioned area (forced change of air, above 5°C)	1 321.0	16.1	2 326.0	28.3	(−) 43.3
Additional area	—	—	1 072.0	13.0	(+) 13
Energy	GJ/24 h	%	GJ/24 h	%	
Total requirements	3.3	100.0	2.4	100.0	(+) 27.1
Losses of energy	2.3	69.9	1.9	76.3	(+) 20.0
Heat radiated by products (including variety meats and fats)	1.0	30.4	0.6	23.9	(+) 43.2
Heat radiated by meat and meat products	0.9	27.1	0.5	19.2	(+) 49.4

2) the air-conditioned area rises from 16.1 to 28.3% of the total production space in the case of delay-chill method,

3) utilizing new technology approximately 13% of space may be saved and used for other purposes than cooling,

4) total energy requirements (including losses of energy) are 3.3 GJ/ /24 h and 2.4 GJ/24 h for conventional and delay-chill methods, respectively,

5) from the total energy cost 27.1% is used in conventional method for cooling sides and processed meats, and in delay-chill method only 19.2%.

Generally it can be concluded that energy requirements to cool meat and meat products might be reduced approximately by 50% (table 2) after introduction of hot processing in a plant with redesigned flow lines pattern.

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Streszczenie

W układzie modelowym porównano dwa zakłady mięsne: zakład o tradycyjnej technologii z wychładzaniem półtusz po uboju oraz zakład o zmienionych liniach przepływu masy surowej i gotowego produktu, bazujący na nowej technologii „na ciepło". Dla obu zakładów przyjęto do obliczeń ten sam wyjściowy program produkcji. Ustalono, że wprowadzenie metody „na ciepło" pozwala uzyskać 13% dodatkowej powierzchni produkcyjnej. Ponadto wykazano, że niezbędna powierzchnia chłodzona dla nowej technologii jest o około 70% mniejsza niż w przypadku metody tradycyjnej. Obliczenia energetyczne wykazały, że zapotrzebowanie energii niezbędnej dla wychłodzenia mięsa i produktów mięsnych w przeprojektowanym zakładzie jest o około 50% mniejsze niż w przypadku zakładu konwencjonalnego.