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Nutritional Effects of Processing

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In recent years, a considerable change has been taking place in the thermal preservation of foods. One which has elicited considerable interest is H. T. S. T. (High-Temperature Short-Time Processing). In conventionally sterilized products, heat transfer is very slow in products which are non-liquid. Since the heat enters the product through the periphery of the container, the material close to the edge is subjected to a far more drastic heat than required to achieve sterility. By sterilizing the product prior to packaging, it is possible to subject the entire food material to the same heating-cooling cycle. By increasing the temperature of uniform heating, it is possible to take advantage of an increased rate of lethality to microorganisms without concomitant chemical changes induced by

higher temperatures. In processing food materials in scraped-surface heat exchangers or other agitated exchangers under pressure, it is possible to thermally sterilize products such as bean puree, meat, pea puree, etc., at temperatures exceeding 300 °F in times shorter than one minute. The net effect of this type of processing is to decrease the cooking effect, while maintaining the commercial sterilizing characteristics of thermal processing. In a series of investigations of the high-temperature short-time processing and aseptic canning of food materials it was found that the cooking effects, and thus the chemical changes induced by heating, were substantially reduced, while sterility was maintained. A comparison between the total heat treatment utilized in aseptic process versus the conventional process shows that for small containers conventionally processed the ratio between the magnitudes of the two cooking effects is approximately 8. If the same product were filled into larger containers (such as No. 10 tin cans) the difference would have been of the order of 200 times. The relative sterility is actually considerably higher for the aseptically processed products than the conventionally processed product.

With the reduction in cooking effect one would expect a reduction in chemical changes which might take place. In experiments with beef, it was found there were considerably fewer flavor changes encountered, fewer changes in flavor, in color, and a smaller production of sulfhydryl compounds. In products such as lima beans there were considerably smaller changes in the aseptically processed material in color, flavor, and texture. Other products showed essentially the same differences.

Nutritionally, the two processes were studied with respect to thiamine and pyridoxine, and the differences between the processes are shown in Table I.

Table I. Effect of processing method on nutrient retention

	Beans	Beef	Tomato Juice
Pyridoxine			
Initial (μg/100 gm)	64.1	126.6	412.5
% Retention HTST process	93.0	98.3	100
% Retention conven. process	86.7	94.2	100
Thiamine			
Initial (μg/100 gm)	93.8	150.0	167.1
% Retention HTST process	87.1	95.0	100+
% Retention conven. process	55.9	78.4	97

Since both the low-acid products require considerably more heat treatment to achieve commercial sterility than the high-acid product, larger differences are noted in these products. High-temperature short-time processing thus shows more of its advantages in overall quality in the low-acid products when compared to the high.

In the processing of cereal grains for the production of formula foods with a comparatively well-balanced amino acid pattern, a process of extrusion compression has been developed. In this process the dry cereal ingredients (with or without fortification) are heated in a screw-press and expanded through a die. Temperatures of the order of 300 °F and processing times of minutes are usually required. The process lends itself

to very high production rates of formulated foods with a small initial capital investment, and has a low cost per unit product produced. For this reason, serious consideration has been given to the production of low-cost high-protein foods based upon this process.

Some cereals are particularly sensitive to heat damage, wheat being one of these. In a series of experiments we processed a formulation consisting of 10 % non-fat dried skim milk mixed with 90 % wheat and processed at different temperatures. (Protein content of the formula averaged approximately 17 %.) The minimum temperature considered was that required for glutenization of the wheat.

The Protein Efficiency Ratio of the wheat-milk mixtures was determined by feeding groups of 10 male, weanling, Wistar rats for approximately four weeks. These were fed at a 10 % protein level. Table II shows the results of such a test.

Table II. Effect of temperature of processing and raw materials on the P.E.R. of wheat-milk mixtures

	Averages of 10 rats		
	wt. gain	protein intake	P.E.R.
1. Mixture of low protein wheat (9) with NFDM (1)	57.7	25.3	2.28
Mixture I processed at 270° F	46.8	24.7	1.89
Mixture I processed at 290° F	36.5	21.7	1.68
2. Mixture of high protein wheat (9) with NFDM (1) processed at 270° F	30.1	21.3	1.41
Mixture II processed at 290° F	10.0	16.5	0.60
Casein Control	25.1	11.3	2.31

It is noted that with equivalent residence time, a change of 20 ° F in the jacket temperature of an extruder decreased the Protein Efficiency Ratio by (in one case) 12 %, but in a different wheat sample (having slightly higher protein content) by a factor of 58 %. Thus it can be seen that some cereal proteins, when processed by extrusion, are extremely sensitive to small temperature changes in the process, and even more sensitive to changes in the raw material utilized in their formulation. There is very little information available to indicate the magnitude of changes which might be expected with other cereal grain mixtures. But the loss of 58 % in PER with the change of processing temperature by 20 % is quite surprising.