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This project report summarizes the effects of increasing the thermoprocessing temperatures on organoleptic and analytical qualities. The historical processing guidelines states that the Tray Pack products shall be retorted at 240°F until a sterilization value of not less than six is achieved. However, since at higher temperatures sterility is achieved sooner, the thrust of the evaluation was to investigate the organoleptic qualities of 11 selected items processed at elevated temperatures of 250°F and 260°F. Additionally, the four items in sauces were analyzed for colorimetric and viscosity changes. The bench panel and technical sensory panel data indicate there were no significant adverse changes in any of the items. The colorimetric analysis shows that only minor if any color changes occur as the processing temperature increases. The viscosity testing demonstrated that in only one case was the flow rate of an item effected, however, no adverse sensory data was noted. Taking all the above into consideration, it is apparent that the processing temperature should not be stipulated in the item specifications. This requirement was removed from all specifications FY87-FY89 during document revision.

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PREFACE

The Product Development and Engineering Branch (PD&EB), Food Technology Division, Food Engineering Directorate (FED), Natick performs research and development efforts on operational rations for all military foods introduced into the Department of Defense subsistence system. This project was initiated in order to refine the thermoprocessing of Tray Pack food items. This project was supported by the Soldier Science Directorate, Natick which conducted the technical acceptance panels. From this testing and evaluation, Natick has been able to remove a restrictive temperature requirement from the thermoprocessing of all Tray Pack products. The result was improved quality and cost effective processing.

ACKNOWLEDGMENTS

The author wishes to thank the principal investigator, Mr. Michael Sirois, previously of Product Development & Engineering Branch, FED, Natick, who provided the technical support for the production and thermoprocessing of the Tray Pack products. Thank you to the various persons who handled the technical sensory testing in the Behavioral Science Division, SSD. Thanks also go to Mr. Gary Shults, Chief, Product Development & Engineering Branch, (FED), who has always enthusiastically supported the Tray Pack Program and contributed a much needed and welcomed advocacy.

INTRODUCTION

The Tray Pack or T Ration is the cornerstone of the Army Field Feeding System (AFFS). The advent of T Rations has significantly reduced foodservice labor, water and fuel requirements in the field. This is because the T Rations require no preparation other than heating in boiling water for 15 to 45 minutes. Each Tray Pack is a single menu item and provides 9, 12 or 18 servings per traycan. The half steam table size can serves as a package, heating vessel, and serving tray. A Trayb Pack is rectangular in shape being roughly 12 inches long by 10 inches wide by 2 inches deep with a shoulder approximately 1/4 inch wide all around at the 1 1/2 inch height level to accommodate insertion into a steam-table heater. This flat configuration of the traycan creates the potential for an improved food quality when compared to a #10 round metal can, since the thermoprocessing time required for sterility is shortened by approximately 50 percent. The shallow depth also allows rapid and uniform heating of the food, while the large top allows for easy and convenient serving.

To date, the T Ration program has 72 different menu items consisting of entrees, starches, vegetables, fruit desserts and cakes. Forty of these products make up the 10-day rotating field menu. The T Ration is procured as a unitized meal module which includes all Tray Pack menu items, condiments (coffee, creamer, cocoa and beverage bases) and eatingware (5-compartment tray, plasticware and cups). The unit of issue is 18 meals per module.

BACKGROUND

The high-temperature sterilization process presents many problems because physical changes take place in the contents of the can. First, it is necessary to know what is the best sterilization temperature and how long the product must be subjected to that temperature to obtain sterility.

All ordinary vegetative bacteria are destroyed at a temperature of 176 degrees Fahrenheit; but it takes 30 minutes to inactivate spore-forming bacteria at a temperature of 230 degrees Fahrenheit[1]. At higher temperatures (over 230^{o}F) the time of the process is reduced. At a temperature of 250 degrees Fahrenheit it requires only 3 minutes to destroy spore-forming bacteria.

The total time to sterilize a can of food depends on (1) the size of the can, (2) the rate of heat penetration to the center of the can, and (3) the processing temperature which is used to obtain a wholesome product. Additionally, heat penetration is affected by the consistency of the product and whether or not the containers can be shaken and rotated to obtain faster heat penetration[4] during the process.

For this study the first two parameters are knowns; the volume of the traycan remains constant and the rate of heat penetration is monitored by thermocouples imbedded into the side of the traycan. The processing temperature is the parameter which was investigated in order to facilitate the thermoprocessing while maintaining a sterile,

highly acceptable product. The historical processing guidelines stated that the traycans shall be retorted at 240 degrees Fahrenheit until a sterilization value, Fo , of not less than 6, is achieved. Since at higher temperatures sterility is achieved sooner, the thrust of the evaluation was to investigate the sensory qualities of 11 sensitive products processed at two higher temperatures. Four items in sauces were also selected for analysis using colorimetric and vicosity methods.

EXPERIMENTAL DESIGN

SENSORY EVALUATION

The 11 Tray pack products were selected based on their sensitivity to thermoprocessing. The items are as follows: Breakfast bake, chicken stew, chicken cacciatore, chicken and noodles, chicken breasts in gravy, mixed vegetables, cream style corn, eggs with bacon and cheese, macaroni and beef, macaroni and cheese and lasagna. From our extensive storage study data[5] it is known that these items may exhibit darkening, syneresis of the gravies, or flavors and odors not typical of the item. All products were prepared according to specification.

The process temperatures selected were 240, 250 and 260 degrees Fahrenheit. Twelve traycans of each product were produced, with four traycans of product retorted at each of the three temperatures. A stationary water cook retort was used.

There are some fundamental differences in the equipment and operation procedure for the thermal processing systems used in the sterilization of foods packaged in the traycan. These differences result from both container configuration and heating/cooling properties. Good manufacturing practices dictate that the over processing of Tray Pack products should be avoided[2].
Briefly, there are four principle differences between retorting cylindrical cans and the traycan: (1) With the exception of a steam/air retort, the traycan is processed under water; (2) steam/air and/or water circulation are used to provide heat distribution within the retort; (3) air pressure override is used during both the heating and cooling cycles to prevent damage to the can; and (4) the temperature in the retort is controlled independently of the pressure.

After thermoprocessing , each product was bench paneled with food technologists familiar with the sensory attributes of the Tray Pack products. The 11 products were also evaulated by a technical panel conducted by the Sensory Analysis Section of the Soldier Science Directorate. The technical evaluation encompassed all sensory attributes, appearance, odor, flavor, texture, and overall quality. The 9-point hedonic rating scale was used in the sensory evaluations. The range is 1 = dislike extremely to 9 = like extremely.

Four of the 11 items are in sauce, cream style corn, chicken and noodles, chicken cacciatore, and chicken breasts in gravy. These items were further evaluated for changes in viscosity or the flow rate of the gravy using the Bostwick method and analyzed by colorimetry. Colorimetric analysis can detect subtle color changes resulting from the process variables.

RESULTS

A. Bench Panel and Technical Panel Evaluations

The 11 products were bench paneled and technically paneled individually. The data will be presented in catagories.

The processing time, temperature, and sterilization value, Fo, for each of the chicken items are as shown in Table 1.

TABLE 1. Processing Parameters for Chicken Items

Item	Temperature (^{o}F)	Time (min)	Fo Value
Chicken Stew	240	90	6.71
	250	54	8.36
	260	39	8.99
Chicken Breasts	240	81	6.07
	250	57	7.30
	260	43	7.09
Chicken Cacciatore	240	65	6.28
	250	54	9.16
	260	49	7.62
Chicken & Noodles	240	76	8.83
	250	58	6.53
	260	39	10.46

The bench panel evaluation concluded that the four chicken items, chicken breasts in gravy, chicken cacciatore, chicken and noodles and chicken stew, exhibited no perceptable differences at the three processing temperatures.

The technical panel ratings for the chicken items are in Table 2.

TABLE 2. Technical Panel Sensory Ratings for Chicken Items

Item	Appearance	Odor	Flavor	Texture	Overall
Chicken Stew					
240°F	7.1a	6.9a	6.7a	7.1a	6.8a
250°F	7.0a	7.0a	6.8a	6.9a	6.9a
260°F	7.2a	7.1a	7.0a	7.1a	7.0a
Chicken Cacciatore					
240°F	7.1a	7.1a	7.0a	6.8a	6.9a
250°F	7.0a	7.1a	7.1a	6.6a	6.9a
260°F	6.9a	7.0a	7.0a	6.7a	6.8a
Chicken Breasts					
240°F	7.1a	7.1a	7.0a	6.8a	6.9a
250°F	7.0a	7.1a	7.1a	6.6a	6.9a
260°F	6.9a	7.0a	7.0a	6.7a	6.8a
Chicken & Noodles					
240°F	6.9a	6.8a	6.3a	6.2a	6.1b
250°F	6.9a	6.9a	6.4a	6.3a	6.5ab
260°F	7.1a	6.9a	6.7a	6.5a	6.8a

a = Not significantly different at the 0.05 percent level
ab = Not significantly different at the 0.05 percent level when compared to a or when compared to b.
b = Significantly different than a at the 0.05 percent level

The technical panel results indicate that the four chicken items processed at 240, 250 and 260°F show no appreciable differences in sensory quality. The sole difference was the overall quality ratirg of the chicken and noodles. The ratings indicate a significant improvement in the overall quality at 260°F when compared to the ratings at 240 or 250°F. This may be attributed to the vast

time difference for processing between the 240°F and the 260°F processed products, 76 minutes versus 39 minutes, respectively.

The thermoprocessing time, temperature and sterilization value, Fo for each of the macaroni items are in Table 3.

TABLE 3. Processing Parameters for Macaroni Items

Item	Temperature	Time (min)	Fo Value
Macaroni & Cheese	240	90	6.71
	250	54	8.36
	260	39	8.99
Macaroni & Beef	240	77	6.21
	250	61	6.72
	260	39	6.55
Lasagna	240	70	7.98
	250	41	8.99
	260	18	13.96

The bench panel concluded there were no significant differences, including a loss of texture or darkening of color, in the above three macaroni based items, which storage data indicates may happen[6].

The technical panel ratings for the macaroni items are in Table 4.

TABLE 4. Technical Sensory Results for Macaroni Items

Item	Appearance	Odor	Flavor	Texture	Overall
Macaroni & Cheese					
240°F	6.8a	6.5a	6.7a	7.0a	6.6a
250°F	6.8a	6.6a	6.8a	6.9a	6.8a
260°F	6.7a	6.7a	6.8a	6.3a	6.3a
Macaroni & Beef					
240°F	7.1a	7.2a	7.3a	6.8a	7.1a
250°F	7.3a	7.2a	7.2a	7.0a	7.2a
260°F	7.1a	7.2a	7.1a	6.8a	7.0a
Lasagna					
240°F	7.2a	7.1a	7.4a	7.1a	7.2a
250°F	7.3a	6.9a	7.4a	6.9a	7.2a
260°F	7.2a	6.9a	7.2a	7.1a	7.2a

a = Not significantly different at the 0.05 percent level

The technical panel results indicate that the three macaroni items processed at 240, 250, and 260°F show no discernable differences in any sensory attributes. It is interesting to note that even though the minimum Fo value for Lasagna was exceeded at 260°F, no appreciable changes were noticed.

The processing time, temperatures and sterilization value, Fo for the two vegetable items are at Table 5.

TABLE 5. Processing Parameters for Vegetable Items

Item	Temperature	Time (min)	Fo Value
Mixed Vegetables	240	43	9.83
	250	13	9.32
	260	3	15.00
Cream Style Corn	240	65	5.46
	250	47	6.67
	260	35	9.42

The bench panel concluded that there was a small perceptable difference among the vegetables processed at the various temperatures. The vegetables processed at 260°F were judged to be of the highest quality and those processed at 240°F were the lowest. However, all were considered acceptable.

The technical panel ratings for the vegetable items are in Table 6.

TABLE 6. Technical Sensory Results for Vegetable Items

Item	Appearance	Odor	Flavor	Texture	Overall
Mixed Vegetables					
240°F	6.5a	6.6a	6.1a	5.7a	6.0a
250°F	7.1a	6.7a	6.6a	6.1a	6.5a
260°F	6.8a	6.7a	6.5a	6.0a	6.4a
Cream Style Corn					
240°F	7.0a	7.2a	6.9a	7.1a	6.9a
250°F	7.4a	7.3a	7.3a	7.3a	7.3a
260°F	6.7a	7.2a	6.7a	7.1a	6.7a

a = Not significantly different at the 0.05 percent level.

The technical panel results show that there are no significant sensory differences in the vegetable items processed at the various temperatures.

The final two items are breakfast products; breakfast bake and eggs with ham. The processing time, temperature and sterilization value, Fo for the two items are in Table 7.

TABLE 7. Processing Parameters for the Breakfast Items

Item	Temperature	Time (min)	Fo Value
Breakfast Bake	240	96	5.41
	250	56	5.13
	260	54	12.31
Eggs w/ Bacon & Cheese	240	90	6.54
	250	61	7.68
	260	50	10.52

The bench panel results concluded there were some minor color changes in both of the breakfast items as the temperature increased. However, it is noted that the minimum sterilization value for both items was considerably exceeded at 260°F. Additionally, the panel noted that at this level of thermoprocessing the breakfast bake exhibited a slight syneresis having 20 mL of free liquid on the bottom of the traycan and the eggs with bacon and cheese showed some evidence of flavor intensification. Both of these attributes would negatively effect an item over its shelf life.

Colorimetry Analysis

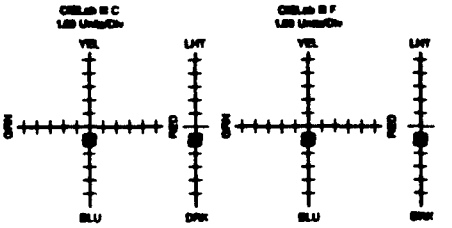
Colorimetric analysis using the "Spectrogard Color System" was performed on the four Tray Pack items in sauces, cream style corn, chicken breasts in gravy, chicken stew, and chicken cacciatore. The standard was the item processed at 240°F. Each item was analyzed at 240 ° versus the sauce processed at 250°F and 260°F. Additionally, the item processed at 250°F was analyzed versus the item processed at 260°F to further differentiate the associated color changes. The colorimetric analysis was done under average daylight (CIELab III C) and flourescent light (CIELab III F). The color scales used were light/dark (L), green to red (a), yellow to blue (b) and the total color difference (DE) of the CIELab color scale. The colorimetric analysis of the items are in Tables 9 through 11.

TABLE 9 Colorimetric Analysis of Cream Style Corn

Cream Style Corn

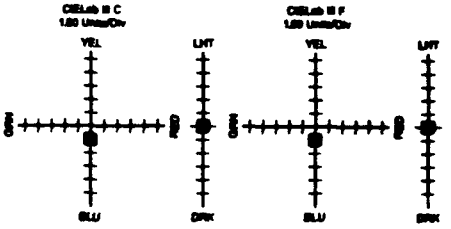
260°F versus 240°F

		Sample	Standard	Delta
C	L	56.19	57.29	-1.10
	a	-0.34	-0.55	0.21
	b	32.39	33.42	-1.03
	DE			1.52
F	L	57.52	58.67	-1.15
	a	-0.01	-0.18	0.17
	b	34.54	35.62	-1.08
	DE			1.59



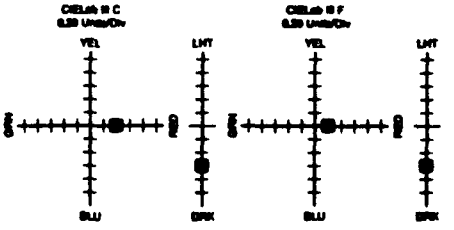
250°F versus 240°F

		Sample	Standard	Delta
C	L	57.20	57.29	-0.09
	a	-0.73	-0.55	-0.18
	b	32.02	33.42	-1.39
	DE			1.41
F	L	58.54	58.67	-0.13
	a	-0.33	-0.18	-0.15
	b	34.16	35.62	-1.46
	DE			1.47



260°F versus 250°F

		Sample	Standard	Delta
C	L	56.53	57.22	-0.69
	a	-0.38	-0.72	0.34
	b	32.15	32.17	-0.02
	DE			0.77
F	L	57.86	58.56	-0.70
	a	-0.06	-0.33	0.28
	b	34.28	34.31	-0.04
	DE			0.76



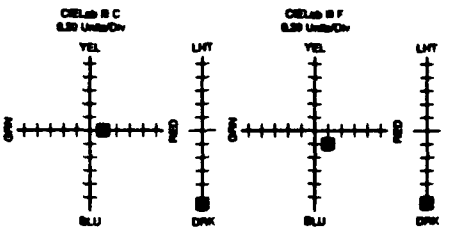
(NOTE: the scale measurements used for the 250°F versus the 260°F sample is 0.20 not 1.0 in order to plot the very small changes.)

The colorimetric analysis from Table 9 shows there are very subtle changes in the three samples as exemplified by the small DE values. However, comparing the 240°F sample, which is always at the zero point of each spectrum, to the 250 and 260°F samples, a color change toward the blue is detectable with a very diminutive darkening on the light/dark scale. When comparing the 250°F sample, which is now the zero point of the scales, to the 260°F sample, a small change toward to the red spectrum and slight darkening is noticed.

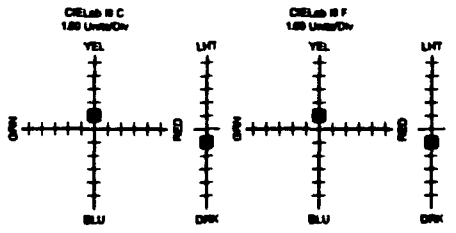
TABLE 10. Colorimetric Analysis for Chicken and Noodles

Chicken and Noodles

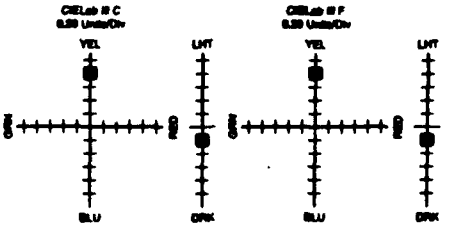
		240°F versus 250°F Sample	Standard	Delta
C	L	63.08	64.02	-0.94
	a	0.97	0.78	0.19
	b	30.92	31.01	-0.09
	DE			0.96
F	L	64.38	65.36	-0.98
	a	1.05	0.87	0.18
	b	33.55	33.66	-0.11
	DE			1.00



		240°F versus 260°F Sample	Standard	Delta
C	L	62.87	64.02	-1.15
	a	0.87	0.78	0.09
	b	31.68	31.01	0.67
	DE			1.33
F	L	64.20	65.36	-1.16
	a	0.99	0.87	0.12
	b	34.39	33.66	0.73
	DE			1.38



		250°F versus 260°F Sample	Standard	Delta
C	L	62.87	63.08	-0.21
	a	0.87	0.97	-0.10
	b	31.68	30.92	0.76
	DE			0.79
F	L	64.20	64.38	-0.18
	a	0.99	1.05	-0.06
	b	34.39	33.55	0.84
	DE			0.86



This item does not show significant changes when analyzed by colorimetry as substantiated by the small DE values. However, the 250°F sample shows a color change towards the red spectrum with some darkening. The 260°F sample shows a very small tendency towards the yellow spectrum with a negligible darkening. It is noted that the scale units are 0.20 since the changes are so small.

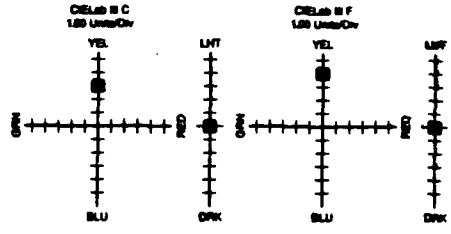
The analysis of the 260°F sample versus the 250°F sample shows a slight yellowing and very slight darkening, neither considered significant. However, if this item was overprocessed, it may not prove adverse since the trend is towards the yellow which is considered typical.

TABLE 11. Colorimetric Analysis of Chicken Cacciatore

Chicken Cacciatore

240°F versus 250°F

		Sample	Standard	Delta
C	L	46.01	46.19	-0.18
	a	18.49	18.15	0.34
	b	43.20	39.80	3.40
	DE			3.42
F	L	48.35	48.47	-0.12
	a	13.01	12.77	0.24
	b	46.67	43.16	3.54
	DE			3.52



240°F versus 260°F

		Sample	Standard	Delta
C	L	45.29	49.19	-0.90
	a	18.44	18.15	0.29
	b	42.95	39.80	3.15
	DE			3.29
F	L	47.62	48.47	-0.85
	a	12.99	12.77	0.22
	b	46.42	43.16	3.26
	DE			3.38

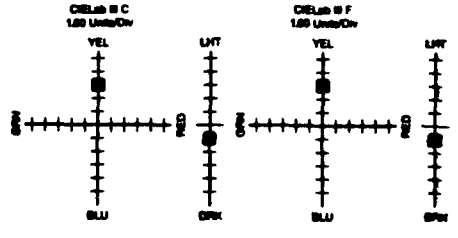
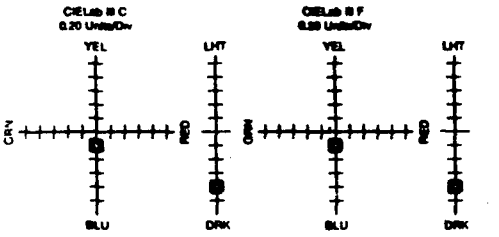


TABLE 11. Colorimetric Analysis of Chicken Cacciatore Cont.

Chicken Cacciatore

250°F versus 260°F

		Sample	Standard	Delta
C	L	45.29	46.01	-0.72
	a	18.44	18.49	-0.05
	b	42.95	43.20	-0.25
	DE			0.76
F	L	47.62	48.35	-0.73
	a	12.99	13.01	-0.02
	b	46.42	46.67	-0.25
	DE			0.77



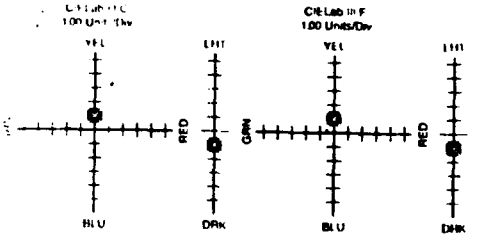
The analysis of the 240°F sample versus the 250 and 260°F samples are very similar in that they both show a moderate change towards the yellow spectrum. However, there is virtually no change in the light/dark scale. The comparison of the 250°F sample and the 260°F sample shows a very small change towards the blue spectrum and a slight darkening.

TABLE 12. Colorimetric Analysis of Chicken Breasts

Chicken Breasts with Gravy

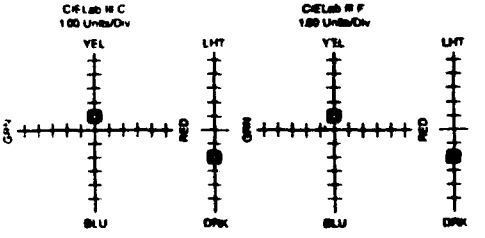
240°F versus 250°F

		Sample	Standard	Delta
C	L	64.05	64.69	-0.64
	a	0.09	-0.22	0.31
	b	20.97	19.82	1.15
	DE			1.35
F	L	64.83	65.43	-0.60
	a	0.69	0.43	0.26
	b	22.92	21.66	1.26
	DE			1.42



240°F versus 260°F

		Sample	Standard	Delta
C	L	62.41	64.69	-2.28
	a	0.26	-0.22	0.48
	b	20.79	19.82	0.97
	DE			2.52
F	L	63.18	65.43	-2.25
	a	0.79	0.43	0.36
	b	22.74	21.66	1.08
	DE			2.52



The color changes exhibited by the two samples, 250 and 260 °, show a slight increase in the color yellow and in its intensity. The 260°F sample is slightly more pronounced but remains not significantly different than the 240°F sample.

Viscosity Testing:

The sauces from the four items in sauces, chicken breast in gravy, chicken cacciatore, chicken and noodles, and cream style corn were evaluated for changes in viscosity as the thermoprocessing temperatures increased from 240 to 260°F. The method employed was the Bostwick method, which measures the rate of flow of the sauce over a finite period of time. The standard temperature used to measure the sauces was 100°F. The timeframes used were 5 seconds and 10 seconds. Table 13 shows the results of the four products.

TABLE 13. Viscosity Testing Results

Item	240°F	250°F	260°F
Chicken Breasts			
5 seconds	3.75"	3.75"	3.75"
10 seconds	4.00"	4.00"	4.00"
Chicken Cacciatore			
5 seconds	10.0"	10.0"	10.5"
10 seconds	11.0"	11.25"	11.25"
Chicken & Noodles			
5 seconds	6.00"	6.00"	7.50"
10 seconds	6.50"	6.50"	8.25"
Cream Style Corn			
5 seconds	8.50"	8.50"	8.50"
10 seconds	9.00"	9.00"	9.00"

Expected deteriorative changes are a thinning of the gravy which may be accompanied by a slight breakdown of the gravy and oiling off. However, the reverse may occur and a thickening of the sauce may result with some starch clumping. In this case, syneresis, or weeping of the sauce, may occur.

It is apparent that in all but one instance, an increase in retort processing temperature does not have a significant effect on the viscosity of the sauces. In this one instance, the chicken and noodles at 260°F, may have been effected by the processing time which produced a sterilization value of 10.46 that is above the required Fo of 6.0 minimum.

DISCUSSION AND CONCLUSIONS

The four methods employed--bench panels, technical sensory panels, colorimetry, and viscosity analysis--gave a broad view of the specific sensory and analytical acceptability of each of the 11 items.

The bench panel concluded that there were no perceptable differences in the four chicken items or the two macaroni items. The two vegetable items actually showed a slight increase in quality as the processing temperatures increased. However, they were not considered significant. The two breakfast items exhibited a slight decrease in acceptability as the processing temperatures increased. However, this may be due to the processing times which were above the requirement.

The technical sensory data indicated there are no significant differences in the nine items tested at the three increasing processing temperatures. The sole exception is the chicken and noodles processed at 240°F which was significantly different (less acceptable) at the 0.5 percent level when compared to the item processed at 260°F. It is interesting to note that even though the minimum Fo value for the lasagna and mixed vegetables was exceeded at 260°F, no appreciable sensory changes were noted.

The colorimetry analysis provided insight into the hue and tone changes of the four items in sauces when processed at increasing temperatures. This analysis was utilized for each item processed at 240°F versus the item at 250 and 260°F, but also three of the four items included an analysis of the 250°F sample versus the 260°F sample. The standard, which is the 240°F sample, is always the zero point at the intersection of the four color ranges. This clearly displays any associated color changes of the sample in question. Additionally, the latter comparison of the 250 versus the 260°F sample displays its associated color differential. The data from these analyses show that only minor, if any, color changes occur in the tested products as the processing temperature increases. Although some color changes are evident from the data, it is noted that the color changes are all toward a color that is complimentary for the item, e.g. yellower gravy for the chicken breasts.

Viscosity tests were conducted for four of the 11 items processed in a gravy or sauce. This is a significant test paramenter, since consistency of the product has the potential to directly influence the overall perception of an item. The data on these items show that in only one case (chicken and noodles at 260°F) was the flow rate of the sauce effected. However, the overall acceptability was not adversely effected as substantiated by the technical panel ratings.

Taking all the above test results into consideration, it becomes apparent that the processing temperature should not be stipulated in each product's specification. Each product has very specific quality parameters for the finished product requirements defined in its specification, such as the product shall show no evidence of excessive heating (materially darkened or scorched) and a viscosity range for the gravy items.

Specifications have been revised and the processing temperatures removed from the requirements. To date, there have been no significant processing problems related to excessive thermoprocessing of an item.

It is noted that half of the approximate 300 pounds of steam or 8.7 boiler horsepower-hour (h.p.hr.), is consumed during one hour processing. The remainder is used during venting[4]. A significant reduction in processing time, as proposed by increasing the processing temperature, will have an associated cost savings for the vendors.

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REFERENCES

1. Thermal Processes for Low-Acid Foods in Metal Containers, 12th Edition, June 1982, National Food Processors Association.

2. Good Operating Procedures for the Half Tray, Central States Can Company, 1987.

3. Canned Food - Principles of Thermal Process Control, Acidification and Container Closure Evaluation, Food Processors Institute, 1988.

4. Jackson, J.M., Shinn, B.M. Fundamentals of Food Canning Technology, Avi Press 1979.

5. Kalick, J., Gagne, S., and Kluter, R. Sensory Analysis of Stored Tray Pack Foods, United States Army Natick Research, Development, and Engineering Center, NATICK/TR-90/010, Dec 1989.

APPENDIX A

SUMMARY OF TECHNICAL PANEL EVALUATIONS

Items	Process Temp (°F)	Process Time (min)	Fo	A	O	F	T	OQ
Chicken Stew	240	90	6.71	7.1a	6.9a	6.7a	7.1a	6.8a
	250	54	8.36	7.0a	7.0a	6.8a	6.9a	6.9a
	260	39	8.99	7.2a	7.1a	7.0a	7.1a	7.0a
Macaroni/cheese	240	77	6.21	6.8a	6.5a	6.7a	7.0a	6.6a
	250	61	6.72	6.8a	6.6a	6.8a	6.9a	6.8a
	260	39	6.55	6.7a	6.7a	6.8a	6.3a	6.3a
Macaroni/beef	240	71	7.00	7.1a	7.2a	7.3a	6.8a	7.1a
	250	35	6.24	7.3a	7.2a	7.2a	7.0a	7.2a
	260	16	7.10	7.1a	7.2a	7.1a	6.7a	7.0a
Chicken cacciatore	240	65	6.28	7.1a	7.1a	7.0a	6.8a	6.9a
	250	54	9.16	7.0a	7.1a	7.1a	6.6a	6.9a
	260	49	7.62	6.9a	7.0a	7.0a	6.7a	6.8a
Chicken Breast/ Gravy	240	81	6.07	7.1a	7.1a	7.0a	6.8a	6.9a
	250	57	7.30	7.0a	7.1a	7.1a	6.6a	6.9a
	260	43	7.09	6.9a	7.0a	7.0a	6.7a	6.9a
Chicken/noodles	240	76	8.83	6.9a	6.8a	6.3a	6.2a	6.1b
	250	58	6.53	6.9a	6.9a	6.4a	6.3a	6.5ab
	260	39	10.46	7.1a	6.9a	6.7a	6.5a	6.8a
Lasagna	240	70	7.98	7.2a	7.1a	7.4a	7.1a	7.2a
	250	41	8.99	7.3a	6.9a	7.4a	6.9a	7.2a
	260	18	13.96	7.2a	6.9a	7.2a	7.1a	7.2a
Cream style corn	240	65	5.46	7.0a	7.2a	6.9a	7.1a	6.9a
	250	47	6.67	7.4a	7.3a	7.3a	7.3a	7.3a
	260	35	9.42	6.7a	7.2a	6.7a	7.1a	6.7a
Mixed vegetables	240	43	9.83	6.5a	6.6a	6.1a	5.7a	6.0a
	250	13	9.32	7.1a	6.7a	6.6a	6.1a	6.5a
	260	3.0	15.00	6.8a	6.7a	6.5a	6.0a	6.4a
Breakfast bake	240	96	5.41	6.8a	6.0a	6.1a	6.5a	6.2a
	250	56	5.13	5.8b	6.0a	6.0a	5.9a	5.7a
	260	54	12.31	5.1b	5.7a	5.6a	5.9a	5.1b