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Pasteurization of dates, time - temperature - humidity relationships

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PASTEURIZATION OF DATES

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CONTENTS

Introduction and History

The use of humidified heated air as a means of pasteurizing packaged dried fruits is of comparatively recent origin. In Fellers[3] original publication on the subject it was shown (1) that dried fruits harbor considerable numbers of molds, bacteria and some yeasts; (2) that at least one outbreak of bacterial infection has occurred from dried fruits; (3) that pasteurization with moist heat could control these deleterious organisms; (4) that from a public health viewpoint, pasteurization marks a definite advance in the merchandising of dried fruits.

The object of this research was to study the factors of time, temperature and humidity in the heat treatment of packaged dates, the aim being to find the ideal combination of these factors which would not only sufficiently pasteurize the dates, but would also make them of a high marketable quality.

Postlethwaite[7] recommends pasteurization as a means of controlling fermentative enzymes in fresh California Deglet Noor dates, but does not mention the effect on the undesirable microorganisms. Sievers and Barger[11] claim that heat treatment above 100°F. is deleterious in the processing of fresh cane sugar (Deglet Noor) dates. In the work noted above the treatment was with hot air, no attempt being made to control

the humidity.

In working principally with artificially dehydrated vegetables, Prescott[8,9,10] found that the bacteria and molds present on these products are chiefly soil and water types. No pathogens were found. Molds survived usually as spores. Bacteria decreased in numbers after long storage, although the mold count remained approximately constant. For microbiological control he recommends storage in bins or containers having adequate protection against bacteria and molds.

Nichols[5] found no sample of dried fruit sterile but isolated no pathogens.

Both of the above writers mention the fact that dried fruits and vegetables are usually cooked before being eaten so that microorganisms are of serious significance only in their spoilage activities in the dehydrated product. However, Hunwicke and Grinling,[4] in England, traced an outbreak of severe colitis to French packaged dates. The causative organism called B. coli tropicalis, the description paralleling that of Escherichia coli. Intestinal coliform organisms were isolated from six packages out of eleven which were examined. The bulk date samples did not show any intestinal bacteria. It was concluded that dates may be contaminated in the repacking process.

As the date is one of the dried fruits which is frequently eaten without cooking, a means of controlling any contamination likely to occur on this product should be of value.

Plate 1. Pasteurizing Cabinet

(A) Wet and dry bulb thermometer

(B) Screen tray holding dates to be pasteurized

(C) Gas plate

(D) Copper pan for catching excess moisture in steam

(E) Main steam line

(F) Steam line to cabinet

Method of Procedure

1. Pasteurizer

A sheet metal cabinet 23 x 15 x 18 inches was used as the pasteurizing unit. The cabinet was set on an ordinary gas plate to obtain the proper dry heat. Low pressure steam from the regular laboratory lines was run in to control the humidity. A closed copper pan was inserted in the steam line between the main pipe and the cabinet to take care of the excess moisture in the steam. A wet and dry bulb thermometer with the bulbs inserted through openings in the top of the cabinet was used to obtain temperature * and humidity data. Humidities could be standardized within a limit of two per cent. (See photograph, Plate 1)

The packaged dates were set on a wire screen tray which allowed ample circulation of the moist air. This tray was placed about 5 inches below the thermometer bulbs, so that the temperature registered by the thermometer would more accurately show the actual thermal conditions around the packaged dates.

Ample circulation of air and steam was afforded by the small openings around the wet and dry bulb thermometer at the top of the cabinet.

2. Test Organism

Pasteurization, as it is understood today, means the

* Note. All temperatures are recorded in degrees Fahrenheit.

destruction by heat of harmful microorganisms in a food product. Obviously the pasteurizing process must not injure the palatability and appearance of the product as a food. The process as first devised by Pasteur, was used essentially to prevent spoilage of wine, without any regard for the destruction of pathogenic organisms. Today, especially with reference to milk, it is understood that pasteurization means destruction of all non-sporulating, disease producing organisms.

Escherichia coli was used in this work as an index of pasteurizing efficiency for the following reasons: (1) while not ordinarily pathogenic itself, it closely resembles the organisms responsible for "food poisoning", in that it develops in the intestinal tract of man in much the same manner as the pathogenic bacteria; similarly it is non-spore forming; (2) the presence of Esch. coli is more easily demonstrated by the use of differential media than any of the actual food poisoning bacteria, and finally, (3) the temperatures at which Esch. coli is killed are approximately the same as those at which the undesirable pathogens are also destroyed. In fact Reavens[1] has advised against the use of the colon bacillus as an index of the efficiency milk pasteurization because its thermal death point is apt to vary and be higher than that required for destruction of pathogens, thus necessitating temperatures in milk pasteurization incompatible with a good product. As it has been found in this work that dates may be heated to a temperature much

higher than that used in milk pasteurization without seriously injuring their value as a food product, the above factor does not affect the use of Esch. coli.in this work.

3. Inoculation

A 24 hour culture of Esch. coli was transferred into 25 cubic centimeters of sterile tap water in a test tube. This suspension of organisms was then used to inoculate packaged dates by means of a cotton swab. Within an hour after inoculation the cartons were placed in the cabinet and subjected to the various heat treatments.

4. Temperature-Humidity Relationships

Temperature-humidity relationships were run for 20, 30, 40, 50, 60 and 80 minutes as follows:

Temperature	Relative Humidities (per cent)						
188°	100	96	82	62	-	-	-
179	100	94	83	79	75	68	61
170	100	92	79	69	62	-	-
160	100	90	78	69	62	-	-
150	100	93	80	-	-	-	-
145	100	93	-	-	-	-	-
140	100	-	-	-	-	-	-

5. Bacteriological Examination

Two dates weighing approximately 12 grams were placed in a bottle with 100 cc. of sterile water and shaken until thoroughly disintegrated. A control was run on the unheated dates to compare with those receiving the heat treatment. Total counts of bacteria, yeasts and molds were made using standard nutrient agar as recommended by the American Public Health Association.(12)

To determine the presence or absence of Esch. coli after pasteurization, one cubic centimeter of the liquor from the shaking bottle (above) was placed in lactose broth. The tubes were then incubated at 98°F. for 24 - 48 hours and if gas appeared at the end of this first period, reinoculations were made into fresh lactose media. If, upon incubation, these fresh tubes yielded positive growth, a loop full of the broth was streaked on Endo's agar. If characteristic colonies with metallic sheen and acid production were evident on this media, the determination was considered positive.

6. Heat Penetration Studies

A thermometer was placed at the center of one carton of dates during each run, in order to note the temperature reached at this point at each of the various time intervals.

7. Physical Characteristics

A. Moisture determination.

A composite sample of the dates before pasteurization,

Plate 2. Moisture Determination Apparatus

(A) Condenser

(B) Bidwell-Sterling graduated tube

(C) Flask holding sample and toluene

and samples from each of the various packages after removal from the oven were taken for moisture determinations, in order to ascertain just how much moisture was added during the heat treatment. (See photograph of equipment. Plate 2)

B. Organoleptic examination

Examination of the physical quality of the dates was made after each run to compare with the untreated samples to note improvement or deterioration of quality. The dates were judged on the basis of color, odor, texture and flavor, a grade being given as follows: excellent, good, fair, poor.

Influence of Heat Treatment on *Esch. coli* Destruction in Dates

Table I shows the effect of the various time - temperature - humidity relationships on the destruction of the test organism.

Table I. Influence of Heat Treatment on *Esch. coli* Destruction in Dates.

Dry temp. °F	Relative Humidity %	Time in Minutes 20	30	40	50	60	80
188	100	-	-	-	-	-	-
188	96	-	-	-	-	-	-
188	82	-+	-	-	-	-	-
188	62	+-		-	-	-	-
179	100	-		-	-	-	-
179	94	-		-	-	-	-
179	83	+		-	-	-	-
180	79	+	-	-	-	-	-
179	75	+	-	-	-	-	-
179	68	-		-	-	-	-
180	61	+	+	-	-	-	-
170	100	+	-	-	-	-	-
170	92	+	-	-	-	-	-
170	79	+	+	-	-	-	-
170	69	+	-	-	-	-	-
170	62	+	+	++-	-	--+	-
160	100	+	+	+-	-	-	-
160	90	+	+	+	-	-	-
160	78	+	+	+	+-	-	-
160	69	+	+	+	+	-	-
160	62	+	+	+	+	+	-
150	100	+	+	+		-	-
150	93	+	+	+	+	+	-
150	80	+	+	+	+	+	+
145	100	+	+	+	+	+	+
145	93	+	+	+	+	+	+
140	100	+	+	+	+	+	+

\+ Viable *Esch. coli* present

\- *Esch. coli* destroyed

Discussion

Table I shows that a 20 minute treatment of the packaged fruit is efficient only at the higher temperatures and humidities. With only one exception (179° - 68 per cent humidity) were any of the temperature - humidity relations below 179°F - 94 per cent of value in destroying the test organism.

At 30 minutes it would be necessary to maintain a temperature of at least 179°F. and relative humidity of 75 per cent to assure complete pasteurization.

Esch. coli was destroyed by a 40 minute exposure at all temperatures above 170°F. At this temperature it was necessary to have a relative humidity of 69 per cent; however, at a temperature of 180°, 61 per cent was sufficient as was also the case at 188°.

In all tests made above 160°F. and 90 per cent relative humidity 50 minutes was a sufficient length of time to effect destruction of the test organism.

A temperature of 160°F. and a relative humidity of 69 per cent was the lowest combination which could be considered effective with a time factor of 60 minutes. In one case at a higher temperature (170°F.) with 62 per cent humidity one out of three tests showed growth on Endo's medium, but as in this case the characteristic sheen was not observed, the growth was not considered significant.

An 80 minute treatment showed destruction of Esch. coli in all trials down to 150°F. and 80 per cent relative humidity.

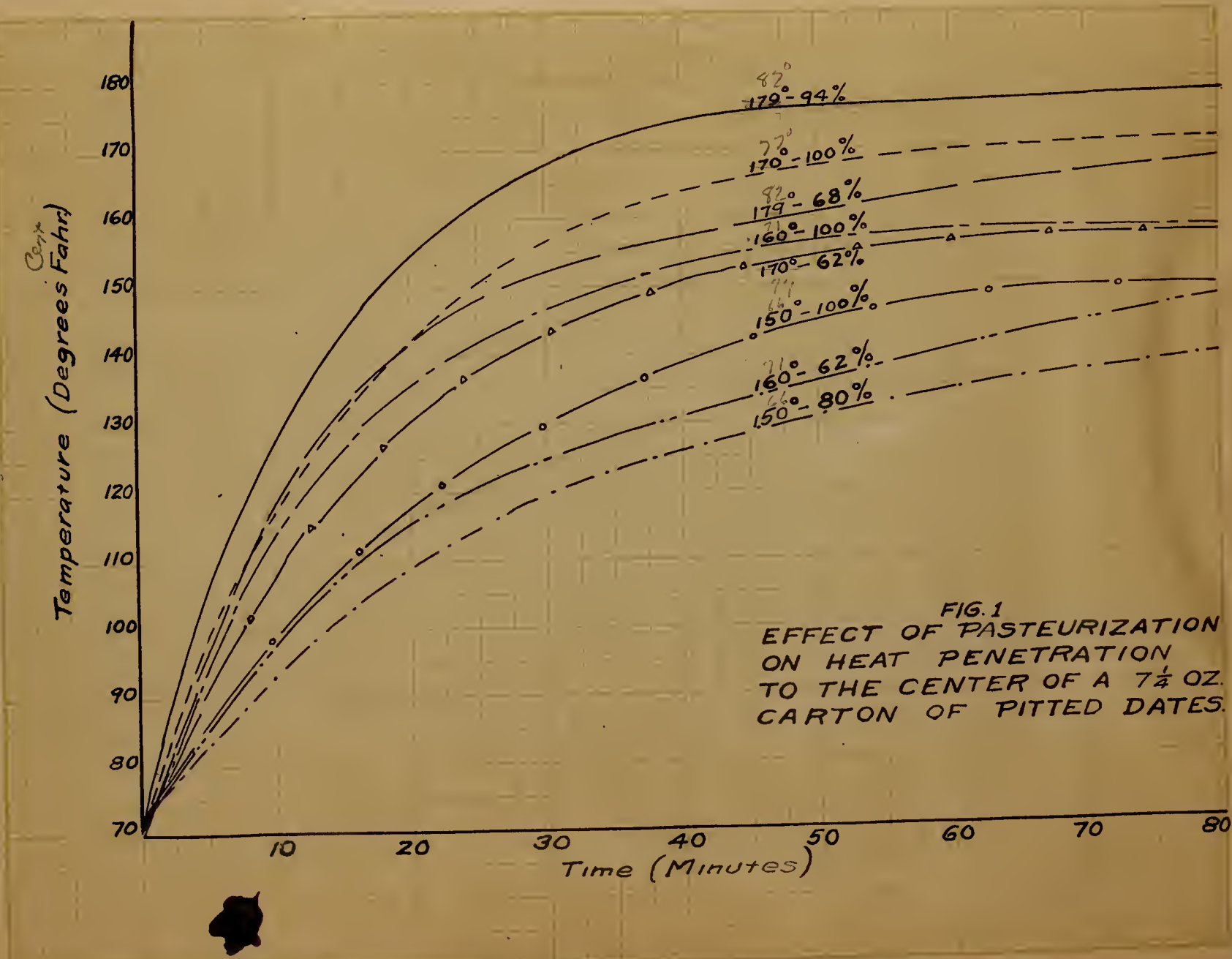

FIG. 1
EFFECT OF PASTEURIZATION ON HEAT PENETRATION TO THE CENTER OF A 7¼ OZ. CARTON OF PITTED DATES.

Table II. Temperatures at Center of Carton of Dates

Dry Temp. °F.	Relative Humidity %	20	30	40	50	60	80
188	100	180					
188	96	162		188			
188	82	163	172	179			
188	62	146		171		181	185
179	100	166		182			
179	94	155		174		177	179
179	83	140		165		173	177
180	79	149		168			
179	75	136		157		165	171
179	68	143		158			171
180	61	138		151		159	
170	100	143	155	164		173	173
170	92	134	148	157		166	171
170	79	131	141	152		162	167
170	69	127	142	147		155	160
170	62	131		146	155	157	160
160	100	137		154	159	159	159
160	90	121		144	149	153	160
160	78	123		137	143	148	155
160	69	114		132	142	1144	151
160	62	116		130		141	148
150	100	118		139		150	152
150	93			126		140	148
150	80	109		126			139
145	100	105		123		134	144
145	93	107		122		134	140
140	100	102		119		129	137

Heat Penetration Studies

Figure I gives a comparison of the heat penetration curves of the higher and lower humidities of several of the runs.

The rate of heat penetration in the cartons of dates is dependent more on the humidity maintained in the pasteurizer than on the dry heat alone. For example, the heat penetration is more rapid in the 170° - 100 per cent run, than in the 179° - 68 per cent run, although the dry bulb temperature is 9° lower in the former case. This fact is also shown in a comparison of the 160° - 100 per cent test with the 170° - 62 per cent test, and the 150° - 100 per cent run with the 160° - 62 per cent.

In Table II is shown the data obtained from the various heat penetration tests. Where more than one run was made at a given temperature the data represents the average of the runs.

The initial temperature of the packaged dates is an important fact to be considered. As the samples used in this experiment were kept in the laboratory for at least 24 hours before being heat treated, the initial temperature in the package was 70°F. or above before being put in the pasteurizer. It would be advisable to have the dates at a temperature of at least 65°F. before submitting them to the process, to assure proper heat treatment.

Effect of Heat Treatment on Physical Quality of Dates

In table III are presented the results of the organoleptic examination of the dates after the heat treatment.

At the higher temperatures the dates acquired a dark color and a caramelized odor and flavor when heated for too long a period of time.

At the lower temperatures and humidities the dates did not absorb the moisture well except when processed for a long time. The best quality dates were obtained in the 60 minute runs at temperatures of 170°F. and 160°F.

Regarding the physical properties, no definite time temperature and humidity relationship could be stated as being optimum, but as noted above the majority of the better quality dates were to be found in the packages run at 170°F. and 160°F. at the 60 minute time interval.

Unpublished results[6] from the University of California show that pasteurization does not destroy the vitamins A, B, and C in dates, although this fruit has been found to contain but little vitamin C.

Table III. Influence of Heat Treatment on Physical Quality of Dates

Dry Temp. °F.	Relative Humidity %	Time in Minutes 20	40	60	80
188	100	Good	Poor	Poor	Poor
188	96	Fair	Poor	Poor	Poor
188	82	Fair	Fair	Poor	Poor
188	62	Good	Good	Fair	Poor
179	100	Good	Good	Fair	Fair
179	94	Good	Fair	Fair	Fair
179	83	Good	Good-Ex.*	Good	Fair
179	75	Good	Good-Ex.	Good	Good
179	68	Fair	Good	Good	Fair
170	100	Poor-Fair	Fair	Ex.	Good
170	92	Poor-Fair	Fair	Good	Good
170	79	Fair	Good	Ex.	Ex.
170	69	Fair	Fair	Good	Good-Ex.
170	62	Fair	Fair	Good	Good
160	100	Fair	Fair	Good	Good-Ex.
160	90	Poor	Fair	Good-Ex.	Ex.
160	78	Fair	Fair	Good	Good
160	69	Fair	Fair	Good-Ex.	Good-Ex.
160	62	Poor-Fair	Fair	Good	Good
150	100	Poor	Fair	Good	Good
150	93	Poor	Poor	Fair	Fair
150	80	Poor	Poor	Fair-Poor	Fair
145	100	Poor	Poor-Fair	Fair	Fair
145	93	Poor	Poor	Fair-Good	Good
140	100	Poor	Poor	Poor-Fair	Fair-Good

*Excellent

Table IV.

Effect of Pasteurization on Moisture Content.

Temp. °F.	Relative Humidity %	Moisture Content				
		Untreated Check	No. of Minutes in Pasteurizer 20	40	60	80
188	100	17.7	19.0	20.5	21.9	21.9
188	96	15.2	19.5	20.2	18.3	17.3
188	81	14.4	15.8	16.0	16.3	15.5
188	62	17.9	18.3	20.3	20.5	17.5
179	100	18.0	18.5	18.3	19.5	18.3
179	94	18.3	17.5	20.1	20.0	19.4
179	93	18.0	18.3	18.7	19.8	20.0
179	75	18.1	18.7	16.5	18.4	17.5
179	68	18.1	18.3	19.0	18.8	19.2
170	100	17.7	18.8	20.0	20.5	19.5
170	94	17.1	17.5	19.7	18.5	18.0
170	82	17.0	17.8	18.3	17.4	17.8
170	72	17.5	16.5	17.5	16.5	17.0
170	63	17.5	17.3	17.6	17.5	17.9
160	100	15.8	18.3	19.8	18.5	18.8
160	93	16.8	17.7	18.6	19.4	17.8
160	81	16.6	18.4	17.5	18.0	19.0
160	71	15.7	15.8	16.5	16.5	16.5
160	62	12.9	14.3	15.5	15.3	15.8
150	100	15.0	16.3	16.2	16.3	16.0
150	93	18.8	15.3	15.8	15.3	13.6
150	80	13.5	12.8	14.0	15.0	14.8
145	100	14.3	15.0	16.0	15.8	17.5
145	93	13.0	14.1	14.5	14.0	15.0
140	100	13.2	14.0	14.5	15.3	15.0

15.0 16.4 1.3 17.3 2.1 17.7 2.1 17.0 1.8

Effect of Pasteurization on Moisture Content.

Moisture determinations were made on 100 samples using a modified Bidwell-Sterling method[2]. Twenty grams of finely cut dates are added along with a few grams of pumice to 150 cubic centimeters of toluene in a round bottomed flask. (See picture). Upon heating the flask the water vapor and toluene distil into the reflux condenser and drop down into the graduated tube where the water settles down in the tube and the amount is read directly in cubic centimeters. The toluene is lighter than water and overflows back into the distilling flask.

It was impossible to use the same dates for moisture determinations before and after the heat treatment. Hence the increase in moisture does not always show a definite trend for every run. In 13 out of 100 cases there is an apparent decrease in the moisture content but inasmuch as each individual date is likely to vary and as it was not feasible to use large samples, it is thought that these decreases are due to the error introduced by the method of sampling.

The average per cent moisture increase at the 20 minute interval was 1.14, at 40 minutes it was 1.7, at 60 minutes 1.8 and at 80 minutes 1.6.

As would be expected, in general the dates run at the higher humidities showed the highest increase in moisture content.

The 170° - 82 per cent and 160° - 71 per cent gave the most desirable results. If too much moisture is added to the

dates it produces conditions favorable for the development of undesirable microorganisms. Yeasts were found to cause souring of dates having too high a moisture content. Nichols[5] states that in vegetables and fruits containing much starch or sugar, spoilage does not occur until 25 - 30 per cent moisture content is reached. Dates would certainly be included in the class of fruits with a high sugar content, and as in no case did the moisture percentage rise above 22 per cent, this treatment should not induce souring or yeasty fermentation.

A slight addition of moisture to the bulk dates as received for repacking improves their quality. It softens the fruit and tends to plump it up, besides greatly retarding the crystallization of sugars. Dates containing about 18 - 21 per cent of moisture have a better appearance and are more palatable than when less moisture is present.

Effect of Pasteurization on Total Organisms on Dates.

Table V gives a comparison of counts before and after pasteurization. The counts are a combination of both bacteria and molds. In some few cases the total count seemed to be increased by pasteurization. This seeming increase was probably caused by a better breaking up of the pasteurized dates in the dilution bottles because of the softening effect of the heat treatment. Since the same dates could not be used for both the "raw" and "pasteurized" counts and because of the wide variation in the contamination of individual dates, these results must be considered only as a whole and not individually.

Table V

Effect of Pasteurization on Total Organisms on Dates

Dry Temp. °F.	Relative Humidity %	Untreated Control	Number of Minutes in Pasteurizer 20		40		60		80	
		Total Count per gram	Total Count	% Reduction	Total Count	% Reduction	Total Count	% Reduction	Total Count	% Reduction
188	100	49	135		270		180		9 9	82
188	96	945	595	37	95	90	180	80	135	85
188	81	343	175	49	130	62	120	65	45	87
188	62	3400	3390	0.3	1200	65	130	96	160	95
179	100	225	190	16	75	66	80	69	180	20
179	94	70	80		150		300		300	
179	83	+	360		450		180		360	
179	75	100	180		230		90	10	80	20
179	68	90	180		270		280		540	
170	100	40	540		135		70		50	
170	94	120	90	25	125		180		215	
170	82	180	305		54	70	81	55	55	69
170	72	585	270	54	180	69	1000		360	38
170	63	4100	+		1540	62	260	94	220	96
160	100	800	215	73	250	69	275	66	100	88
160	93	720	+		260	64	395	47	360	50
160	81	712	+		1170		984		+	
160	71	370	+		+		840		162	56
160	62	314	666		+		560		508	
150	100	450	860		1050		126	72	135	70
150	93	1800	720	60	1440	20	1152	36	261	85
150	80	1116	648	41	450	60	306	73	495	56
145	100	900	650	28	945		1350		441	51
145	93	990	850	14	288	71	607	38	720	27
140	100	2160	1080	50	405	81	963	55	1260	42

+ Overgrown

In the majority of cases there is a considerable reduction in the numbers of organisms, especially in the high temperature high humidity, long time runs. However, the per cent reduction does not in general increase proportionally with the higher temperature. Molds survived the heat treatment as well as the bacteria.

Microorganisms on Dates

In this study bacteria and molds were the only organisms found on plating out dilutions of date suspensions. Reports from a commercial laboratory show that yeasts are occasionally encountered. As no special media were used for the detection of yeasts, it is possible that these organisms were present but did not show growth on the nutrient agar.

Spore formers were the principal type of bacteria encountered. Spreaders often obscured the whole plate.

Coliform organisms were tested for on several occasions but were never encountered. The dates used were grown in Irag. The harvest season extends from August to September. The dates are collected, sorted, graded and boxed in 62 pound cases and shipped to New York. The first shipment usually arrives in New York during November. Thus dates are several months old at the least, before being offered to the retail trade. In this period most microorganisms except spore formers die. Another factor in the destruction of bacteria and yeasts is the very high sugar content of the date, averaging over 70 per cent. A study was made of the longevity

of Esch. coli on dates. In one test the organism was found to survive for 20 days. A subsequent run showed survival at the end of 17 days but no later. This explains the failure to find pathogenic non-spore formers in the dates that have been in storage for any considerable length of time.

A yeast was isolated from a sample of dates which had soured. As noted previously in this thesis when the moisture content is too high these organisms find conditions favorable for growth and are apt to cause spoilage.

The molds encountered were chiefly Aspergillus niger, and Rhizopus Nigricans, although Penicillium and some others were also noted.

The molds survived practically all the pasteurizing temperatures. They are not found growing actively on the dates themselves but seem to be present on the fruit in the form of spores and when introduced to a medium suitable for their growth, such as ordinary nutrient agar, they immediately vegetate. Molds, in themselves, are considered to be of only minor sanitary significance.

Effect of Pasteurization on Insect Infestation.

Dates like other dried fruits are often infested with insects such as the Indian meal moth and the saw-toothed grain beetle. Although no special work was done on this subject, it was observed that the pasteurized samples were free from insects, whereas the packaged unpasteurized samples often contained the insects. It was assumed that pasteurization should effect destruction of the infesting insects.

Table VI

Comparative Thermal Death Points of Esch. Coli and Related Bacteria.

	135°F.						140°F.				145°F.		150°F.	
	2½ min.		5 min.		10 min.		2½ min.		5 min.		2½ min.		2½ min.	
	Syrup	Broth	Syrup	Broth	Syrup	Broth	Syrup	Broth	Syrup	Broth	Syrup	Broth	Syrup	Broth
1 Esch. coli A	+	+	-	-	-	-	-		-	-	-	-	-	-
2 Esch. coli B	+	+	+	-	-	-	*		-	-	+	+	-	-
3 Esch. coli C	+	+	+	+	-	-	+		+	-	+	+	-	-
4 Sal. Schotmülleri	+	+	-	+	-	-	+		-	-	-	+	-	+
5 Sal. Enteritidis	+	+	-	+	-	-	+		-	-	+	+	-	-
6 Dys. shiga	+	+	-	-	-	-	-		-	-	-	+	-	-
7 Eberth. typhi	-	+	-	-	-	-	-		-	-	-	+	-	-

\+ Organism not killed

\- Organism destroyed

Comparison of Thermal Death Point of Test Organism with Pathogens

It was thought expedient to compare the bacterial cultures used in testing the efficiency of pasteurization with pathogenic organisms of the type most apt to be found in foods. The object was to correlate the thermal death points of the various organisms and thus determine how indicative the results obtained with Esch. coli were in relation to actual pathogens of the food poisoning group.

The two cultures of Esch. coli used in this work were compared with (1) a third culture of Esch. coli (2) Salmonella schottmülleri (3) Salmonella enteritidis (4) Shigella dysenteriae (Shiga) and (5) Eberthella typhi.

A water bath with a Bunsen burner as the source of heat was used as the medium of studying the thermal death points. Twenty four hour broth cultures of the organisms were used. The thermal death point was studied in broth and in 20% date syrup. The latter was used in order to approximate conditions actually occurring on the date.

Results obtained are shown in table VI. Esch. coli cultures A and B were those used in the experiment. Culture A was found to be less resistant than B, but since B was as resistant as any of the pathogens in the syrup solution, it could be regarded as a good index of pasteurization efficiency.

Tuberculosis Experiment

Since a non-pathogenic organism was used in obtaining the optimum time - temperature - humidity relationships for pasteurization of dates, an experiment was performed using Mycobacterium tuberculosis to find the efficiency of the process in the destruction of a pathogen. Mycobacterium tuberculosis in sputum is as resistant as any of the pathogenic organisms and for this reason was chosen for use in the test.

Three samples of positive tuberculous sputum were obtained from the Leeds Sanatorium and a culture of Mycobacterium tuberculosis hominis from the Bacteriology Department.

Packages of pitted dates (7¼ oz.) were used in the experiment, inoculations being made as follows:

1. Tuberculous sputum spread directly on the dates in the package.
2. Dates opened up and the tuberculous sputum put on the inside of the fruit.
3. Sputum was digested with NaOH, neutralized, centrifuged, and the concentrated material spread on the dated.
4. Suspension of known culture swabbed on the dates.

A sample was taken from one of the inoculated packages as a control and put in 25 cubic centimeters of sterile saline. A portion of this was used later for injection into the test animals. The packages were then placed in the pasteurizer and subjected to heat treatment of 170°F. with a relative humidity of 78 per cent for 50 minutes. Initial interior temperature

was 70°F., and final temperature at the center of the package was 158°F.

One date from each package was then placed in 25 cubic centimeters of sterile saline and shaken until well broken. The resulting saline suspension was filtered through cotton to remove the date membranes and was ready for injection intraperitoneally into test animals.

Ten guinea pigs were used in the experiment as follows:

No. 1 Inoculated with 4 cubic centimeters of saline suspension of pasteurized date with sputum smeared on inside of fruit.

No. 2 Inoculated with 4 cubic centimeters of saline suspension of pasteurized date with sputum spread on the outside of date.

No. 3 Check on (1) Inoculated with 4 cubic centimeters of suspension from unpasteurized date with sputum smeared on inside.

No. 4 Check on (2) Inoculated with 4 cubic centimeters of suspension from unpasteurized date with sputum smeared on the outside.

No. 5 Inoculated with 4 cubic centimeters of suspension from pasteurized date with digested, centrifuged sputum swabbed on the outside of the date.

No. 6 Check on (5) Inoculated with 4 cubic centimeters of suspension from unpasteurized date treated as in (5).

No. 7 Inoculated with 4 cubic centimeters of suspension from pasteurized date swabbed with suspension of Mycobacterium tuberculosis hominis obtained from Bacteriology Department, M. S. C.

No. 8 Check on (7) Inoculated with 4 cubic centimeters of suspension from unpasteurized date treated as in (7).
No. 9 Inoculated with 4 cubic centimeters of suspension from untreated dates.
No. 10 Control - not inoculated.

The pigs were inoculated August 13, 1930. One of the animals died September 16, 1930. The rest were killed by chloroforming on October 21, 22 and 30, 1930, and autopsied by Dr. Van Roekel of the M. S. C. Veterminary Department.

Findings were negative in all the pigs inoculated with the suspension from the pasteurized dates. Controls were positive as shown by autopsy findings and observation of the tubercle organism in stains from the involved tissues, with one exception. The exception noted was in the animal inoculated with suspension of dates swabbed with the culture of Mycobacterium tuberculosis hominis from the Bacteriology Department of M. S. C. This culture had probably lost its virulence.

The control animal inoculated with suspension from untreated uninoculated dates did not show any tuberculous symptoms, and the uninoculated control was also normal.

Summary

In order to eliminate possible pathogenic organisms introduced during the repacking process and to destroy spoilage organisms and insects, experimental pasteurization of the packaged fruit using heated, humidified air, was attempted.

A sheet metal cabinet was set up to study the effect of time-temperature and humidity in the pasteurization of dates. Dry heat was obtained by using a gas plate, humidity was controlled by means of low pressure steam, and a wet and dry bulb thermometer was the guage for recording the temperatures and humidities.

Using Esch. coli as an index of pasteurization efficiency the following minimal processes were obtained:
188°F. for 20 minutes at 96 per cent relative humidity or above.
179°F. for 30 minutes at 75 per cent relative humidity or above.
170°F. for 40 minutes at 69 per cent relative humidity or above.
160°F. for 50 minutes at 90 per cent relative humidity or above.
150°F. for 60 minutes at 100 per cent relative humidity.
145°F. No effective pasteurizing time under 80 minutes.

Heat penetration studies showed that a high humidity is desirable for obtaining rapid penetration of heat.

The results of moisture content determinations indicated that the pasteurization process caused a slight addition of moisture to the fruit. This increase lessened the tendency for sugar crystals to form on the dates and made them a better

appearing and more palatable product.

Spore forming bacteria and molds constituted a considerable part of the microorganic flora found on the dates.

Molds and bacteria were generally present as spores. Total counts made before and after pasteurization showed that the process did not always reduce the total numbers of either bacteria or molds.

The heat treatment effectively destroyed insects, larvae and eggs and decreased the evidences of insect infestation in the packaged fruit. The heat treatment similarly controlled the souring of dates due to the growth of certain yeasts.

A comparison of the thermal death point of the test organism with various members of the so-called food poisoning group of bacteria was made. The strains of Esch. coli were more resistant than Eberthella typhi or Shigella dysenteriae (Shiga) and equally resistant with Salmonella enteritidis and Salmonella schottmülleri.

Efficiency of the pasteurization process in destroying a pathogen was proven by testing the effect of the treatment on dates inoculated with Mycobacterium tuberculosis hominis. Guinea pigs injected with suspensions from pasteurized and unpasteurized dates inoculated with the infective agents showed positive infection from the unpasteurized samples, with the exception of one culture, and negative in all instances in the case of the pasteurized dates.

Conclusions

Pasteurization of dates not only results in a product free from non-sporulating pathogenic bacteria, but also produces a food product which is less perishable and one whose eating qualities are considerably enhanced.

With an initial temperature of 65°F. in the package, the optimum conditions for a good pasteurized packaged date are: (1) Dry temperature 170°F.; (2) Relative humidity - 75 per cent or slightly above (3) An exposure of 50 minutes or more to the process.

The process is commercially feasible and other dried fruits probably can be similarly pasteurized.

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