6/27/68

SURVEY OF MICROORGANISMS ON DRIED FRUIT

A. D. King, Jr., R. K. Fields and F. P. Boyle

Western Regional Research Laboratory

Agricultural Research Service, U. S. Department of Agriculture

Albany, California

Because of increased emphasis and interest in the microbiology of dried fruit and possible ensuing microbial problems, we were asked to conduct a microbiological study on dried fruit. This study has been conducted to examine the microbial flora and to detect members of the genus Salmonella and the sanitary indicator organisms--the coliforms. The dried fruit industry has supported this survey in part.

On the basis of the composition, physical properties, and handling of fruit, some predictions can be made concerning the kind of micro-flora that will be present. By definition the products we are concerned with are dried, i. e., have a reduced amount of water. Because of the loss of water, dried fruit has high concentrations of sugar. The sugar causes high osmotic pressure, which stops growth of most microorganisms. Microbial spoilage will not occur in dried fruit having less than 18-25% moisture, depending upon the fruit and sugar content. Generally, bacteria require the most free water, then yeasts and finally molds can grow in higher concentrations of sugars. Exceptions to this rule are some osmophilic yeasts that will grow on very concentrated sugar solutions.

The acidity of some fruits also reduces the possibility of growth of microorganisms. For instance, most bacteria do not grow below pH 4.0-4.5. At lower pH values (higher acidity) both yeasts and molds are capable of growth.

The processing treatments given a product will influence the kinds and numbers of organisms present. For example, figs should have a low microbial population because of the heat and sorbic acid treatments given the product. Likewise one would expect higher counts on raisins and dates as they receive no substantial heat treatment. The initial number and kind of organisms on the fruit before processing also influence the amount present after processing, providing no lethal treatments, such as heating, are given. The growth of micro-organisms follows a geometric pattern; the more that are present originally, the more growth that may occur and the shorter the product shelf life will be.

During processing the fruit comes into contact with equipment surfaces and workers' hands. If these are not clean, micro-organisms on these surfaces will be transferred to the product during processing, and an increase in the number present will result. The assumption is made that higher counts will be related to a greater risk of contamination by pathogenic microorganisms.

Thus, the composition and physical nature plus the handling of fruits will determine the microbial population. The lack of moisture and high sugar content of dried fruits result in high osmotic pressure which tends to prevent microbial growth. Also the acidity of the fruits inhibits growth and may cause death of organisms. Heat treatments given the product during processing and the influence of added chemicals, such as sorbic acid or sulfur dioxide, may reduce the microbial counts on dried fruits. However, dirty or unsanitary equipment may increase the microbial counts. On the basis of these interrelated factors one would assume that the counts found on dried fruits should be low. Historically this has been the case.

A summary analysis of the samples drawn in the survey is shown in Table I. A total of 293 samples of finished product were collected at processing plants. These were brought to the laboratory and counts were made of bacteria, yeasts, and molds. Analyses were also run to determine the possible presence of Salmonellae and coliform bacteria.

Because of the relatively high concentration (300-500 p.p.m.) of sulfur dioxide, the low pH (3.3-3.5) and the heat treatment given apples during processing and drying, the counts for this fruit are understandably low. Cut fruit (apricots, nectarines, peaches, pears) also have low counts due primarily to the sulfur dioxide content and the low pH of the fruit. All counts on cut fruit were below 800 bacteria per gram except one which was 11,000. The reason for this high count is unknown.

Figs receive a series of heat treatments that will destroy any microbial flora and a sorbic acid treatment that would control any yeast or mold present. Thus, the counts were low as expected. Likewise prunes would be expected to have relatively low counts. This was the case for unpitted prunes except for one unexplained high bacterial count. However, prunes that had been pitted had higher counts.

Raisins receive no treatment that would lower the microbial counts during processing except washing and cleaning. However, the low pH of raisins (3.5) will not allow growth of bacteria and is bactericidal to some bacteria. One would expect that the counts would be somewhat higher than the fruits already mentioned because no heating or chemical treatments are given raisins. The highest counts were from candy coated raisins, oiled raisins, and one package of normally processed raisins.

On the average the counts on dates were the highest of all the fruit examined. This is reasonable because dates are frequently rehydrated so that the moisture can be high enough for a yeast fermentation to occur. Also the pH of dates (5.5-6.0) is the highest of the fruit tested and will allow both bacteria and fungi to grow. Thus, if a microbial population is present on dates it can survive or grow depending upon the moisture condition of the product. The best way to solve this problem is to reduce the counts on the product where possible by using appropriate sanitary processing methods. These comments are based on the data which indicate that the highest counts were on samples of dates that had been exposed to equipment or handling more than other samples, i.e. pitted dates or date products.

A series of tests were set up to determine how long Salmonellae would survive on dried fruit. The results in Table 2 show that survival is short on sulfured fruit (apples and cut fruit) and fruit treated with sorbate (figs and prunes). However, on raisins, which have a waxy dry surface, the survival is somewhat longer. On dates the survival time was at least 50 days.

It is clear then that on some fruit, as normally processed, the survival time is very short but on other fruits longer survival of Salmonellae can be anticipated. The solution to the problem is to use clean equipment, fruit, handling procedures, and packaging materials to prevent contamination with any microorganism.

Analyses for Salmonellae and coliform bacteria were conducted on the samples collected at the processing plants. In no case was any positive isolation of Salmonellae or coliform bacteria made. The results of these analyses are shown in Table 3.

Conclusions

1. Based upon the composition and processing treatments given processed dried fruits one would expect low microbial counts. Results of this survey confirm this expectation.

2. High counts found on dates, prunes, and raisins could be related to a larger amount of equipment or hand processing. This points to the need to maintain clean handling procedures. Some high counts could not be explained.

3. No Salmonellae or coliform bacteria were isolated from the processed fruit samples.

4. Studies indicate that in some cases Salmonellae artificially inoculated onto fruit can survive but on most dried fruit survival time is short.

Table 1

Counts Per Gram of Fruit of Aerobic Bacteria and

Yeast and Mold on Processed Dried Fruits

	Apples	Cut fruit	Dates	Figs	Prunes	Raisins
No. samples analyzed	15	15	29	15	18	50
Bacteria						
Average	274	835	6487	662	3718	2542
Median*	10	53	320	30	0	1500
90% of Counts less than	730	757	21,000	93	4600	8200
Range	0-2600	0-11,000	0-50,000	0-7700	0-50,000	0-60,000
Yeast and mold						
Average	261	23	2478	17	851	3934
Median*	8	0	90	0	0	390
90% of Counts less than	730	52	720	110	6000	20,000
Range	0-1500	0-210	0-30,000	0-120	0-7100	0-30,000

*The median represents the middle number, that is 50% of the counts were above 50% below this number.

Table 2

Survival of *Salmonellae typhimurium* Inoculated onto Dried Fruits and Stored at Room Temperature

	Days of Storage			
	0	7	22	50
Apples[a]	+	-	-	
Cut fruit[b]	+	-	-	
Dates	+	+	+	+
Figs	+	+	-	
Prunes	+	+	-	
Raisins	+	+	+	-

Original population 100,000 per gram fruit

\+ Survivors - No survivors detected

[a] 83 p.p.m. SO_2

[b] 870 p.p.m. SO_2

Table 3

Analysis of Dried Fruits for *Salmonellae* and Coliform Bacteria

	Salmonellae		Coliforms	
	No. analyses	Positive	No. analyses	Positive
Apples	19	0	13	0
Cut fruit	20	0	5	0
Dates	25	0	20	0
Figs	28	0	15	0
Prunes	24	0	10	0
Raisins 1966	30	0	31	0
1967	51	0		