CHEMICAL AND TECHNOLOGICAL STUDIES
ON
THE DEHYDRATION OF CERTAIN EGYPTIAN FRUITS AND VEGETABLES

BY
EL SAYED ABDEL BAR SALEM
B.Sc. (Cairo Univ.) 1961
M.Sc. (Ain Shams Univ.) 1964

A THESIS

Submitted in partial fulfilment of
the requirements for the degree of

DOCTOR OF PHILOSOPHY
(Food Technology)

Food Technology and Dairy Dept.
Faculty of Agriculture
Ain-Shams University

1968

This thesis has been approved by :

. . . . . .

. . . . . .

. . . . . .

Committee in charge.

Date : / /1968.

ACKNOWLEDGEMENT

This work was carried out at the Food Technology Research Unit, National Research Centre.

The writer wishes to acknowledge his gratitude to Prof. Dr. M. Safwat Mohammed, Head of Food Technology Department, Alexandria University, to Dr. Y.H. Foda, Associate Professor of Food Technology, Faculty of Agric, Ain Shams University, and to Dr. M.G.E. Hamed, Associate Prof., and Head of Food Technology Research unit, National Research Centre, for their supervision, encouragement, advice and valuable help during this investigation, and in writing the thesis.

Thanks are extended to the authorities of El-Nasr Company for Dehydrating of Agricultural products.

* * *

C O N T E N T S

* * *

INTRODUCTION

The drying of foods is one of the oldest methods of food preservation known to man. It is used to preserve them during the season of abundance for the consumption during the seasons of shortage. It is considered as an ancient art, its origin is unrecorded, but many of its practices have been handed down even into the present day, and in some cases form the basis of modern food manufacturing processes. Sun-dried dates, figs, apricots, and raisins were produced by the Mideterranean Basin.

The first record of the artificial drying of foods according to Prescott, and Prector (113) appears in the 18th. century.

Production of dehydrated foods in the U.A.R. which was considered in the past as a mere "war baby" has become, a vigorously growing branch of the peace-time food processing industry. The dehydration process started recently in U.A.R. in 1938; the first plant for onion dehydration was erected at Maghagha; Menia province.

From table (1), it can be noticed that there is a great demand for both fresh, and dehydrated onion to supply certain foreign markets.

Table 1 - Production of fresh onion and exports of both fresh and dried onion in U.A.R.*

Year	Total Production	Export			
		Fresh		Dried	
		Weight (tons)	Value 1000 L.E	Weight (tons)	Value 1000 L.E
1952	243945	90164	2304	1942	293
1953	280935	122683	3649	2621	464
1954	356805	169972	2047	2716	296
1955	389610	173567	2312	3245	320
1956	375030	198898	4641	3891	489
1957	451035	152632	2677	4900	721
1958	429030	160058	3498	3893	515
1959	519930	179938	3723	7211	881
1960	504765	169817	3004	5573	598
1961	49755	199627	3381	5206	719
1962	601625	156841	5289	6961	1805
1963	647297	155000	4793	6353	1973
1964	647428	174638	5067	3139	925
1965	669493	159166	5593	5539	1178

* Annual report of Agric. Economics, Ministry of Agriculture, U.A.R. December, 1966 (In Arabic).

The discolouration of the dehydrated onion during storage and the subsequent difficulties in its exportation (as happened in 1964), is one of the serious problems facing this industry. To the author's knowledge, there are no researches concerning this problem.

Recently the U.A.R. has shown great interest in grape growing. One third of the 100,000 faddans that are proposed for vine plantations will be restricted to the Thompson Seedless (Banaty variety), which will be used for dehydration, besides the direct consumption as table grapes.

In addition, the importation of raisins from foreign countries has been restricted in the last few years as shown in table (2). In order to save hard currency for other important purposes, the U.A.R. has recently shown certain interest in the production of raisins.

* * *

Table 2- Production of grapes, exports of fresh grapes, and imports of dried grapes in U.A.R. in tons*

Year	Production (all varieties)	Export	Import (dried)
1952	90070	53.6	1312
1953	94580	51.0	2031
1954	101650	64.4	2012
1955	75052	54.5	1976
1956	80590	51.7	1709
1957	91000	56.1	2053
1958	87800	32.3	256
1959	99292	41.6	1435
1960	102030	57.1	1288
1961	106306	40.0	30
1962	120172	20.5	1149
1963	105412	37.0	2592
1964	90630	10.0	744
1965	90047	63.0	18

* (Personal Communication, Ministry of Supply, and Ministry of Agriculture, U.A.R.).

AIM OF INVESTIGATION

The purpose of this investigation can be summarized as follows :

1- To identify and estimate the free amino acids and sugars which may play the effective role in the over-all reactions leading to discolouration of dehydrated onions and raisins.

2- To find out the suitable treatments for onion and raisins processing with a good quality of the end product.

3- To follow the changes which may take place in dehydrated onions and raisins packaged in different containers and kept under different storage conditions.

* * *

REVIEW OF LITERATURE

I- DEHYDRATION OF ONIONS

The literature on the subject of onions is so enormous that it can hardly be covered in this thesis. However, only peritnent literature is cited.

a) Raw Material

The quality of the end product is mainly dependent on the raw material used. Taking this into consideration, most onion factories maintain a Crop Research Department to specify the quality factors required in the dehydrated onions.

The desirable characteristics of the onion bulbs are high solid, high pungency, white colour, and large bulbs which are able to hold up in common storage for 2 to 3 months with a minimum of rot, shrinkage, or sprouting (113).

b) Some chemical properties of onions

Sugars : There appears to be little information in the literature regarding the nature of onion carbohydrates, which are probably the constituents of great potential significance.

Bennett (11) found 64.23 % soluble sugars, 11.43 % reducing sugars, and 52.89 % non-reducing sugars in the

Ebenezer onion (dry weight basis). He also investigated the nature of the reducing sugars in onions, and reported that, 69 % of the sugars present were of the ketose form, and that the aldose and ketose forms were present in Ebenezer onion, in the ratio of about one to two. Sherratt in 1943 (108) mentioned that, onions appear to contain 6 to 9 % sugars (fresh weight). Bhatia, Satyanarayana and Srinivasan (13) identified the carbohydrates of onions as fructose, glucose, sucrose, and fructosans. In Japan, Kihara (67) stated that, onion bulbs contained 17.91 % non-reducing sugars, 32.34 % reducing sugars, 5.18 % cold water soluble carbohydrates and 4.58 % other carbohydrates. Löhr (77) chromatographically determined sugars in onions, and found that 100 grams fresh weight contained 2.05 grams glucose, 0.90 grams fructose, 3.23 grams sucrose, and 1.45,grams fructosan. In Peru, Flores (38) extensively analysed two varieties of onions. They contained from 5.45 to 6.04 % total sugars. El-Gammal (31) gave 1.916 - 2.199 % , 4.913 - 7.662 %, and 7.111 - 9.747 % for reducing sugars, sucrose, and total sugars respectively in Giza 6 variety grown in Egypt. Vaas (112) also stated that, Hungarian onions contain 8.00 to 11.40 % total sugars. Hussein (57) studied the sugar content of Giza 6 grown in England, and gave a

value of 21.3 % for reducing sugars, 40.3 % for non-reducing sugars, and 61.6 % for the total sugars (dry weight basis).

Ascorbic Acid : Although onions have been reported as being a rich source of vitamin C, the published values range from 0.05 to 0.15 mg./gram (89). Morphy (87) reported that, ascorbic acid of onions ranged from 0.17 to 0.40 mg./gram. She also found that the outer leaves of the onion bulb were lower in their ascorbic acid content than the central leaves.

As a general rule, the majority of green leafy vegetables lose 10 % of their initial vitamin C, for each day's elapse after harvesting, whereas root vegetables lose vitamin C, at a slower rate (57). It was found that, plants growing in the sunlight have more ascorbic acid than those grown in the shade (27). Giza 6 variety contains 38.45 to 89.00(as mg./100 gm.) (57).

Volatile sulfur : The major enzymatic reaction leading to the characteristics odour developed by comminuted tissue of plants of genus Allium and by the dehydrated products prepared therefrom is now well established.

$$R - \overset{O}{\overset{\|}{S}} - CH_2 - \overset{NH_2}{\overset{|}{C}}H - COOH + H_2O \rightleftharpoons$$

$$(RSOH) + NH_3 + CH_3 + CH_3COOH$$

Where R is allyl for garlic and propyl, methyl, and propenyl for onions.

The unstable hydrocarbonyl sulfenic acids (RSOH) interact and decompose to yield a complex mixture of the volatile sulfur-containing compounds (and, to a lesser extent, aldehydes) which are responsible for the characteristic odour of onions. The principal classes of products thus formed, the hydrocarbonyl thiosulfinates and thiosulfonates(R - S - SO-R, and R-S-SO_2-R), can interact with cysteine to form stable disulfides (105).

Platenius (96) made the assumption that pungency is proportional to the volatile sulfur content of the onion. He found that onions differed in pungency not only as a result of genetic factors but also because of