STUDIES ON THE DEHYDRATION OF SOME VEGETABLES

BY

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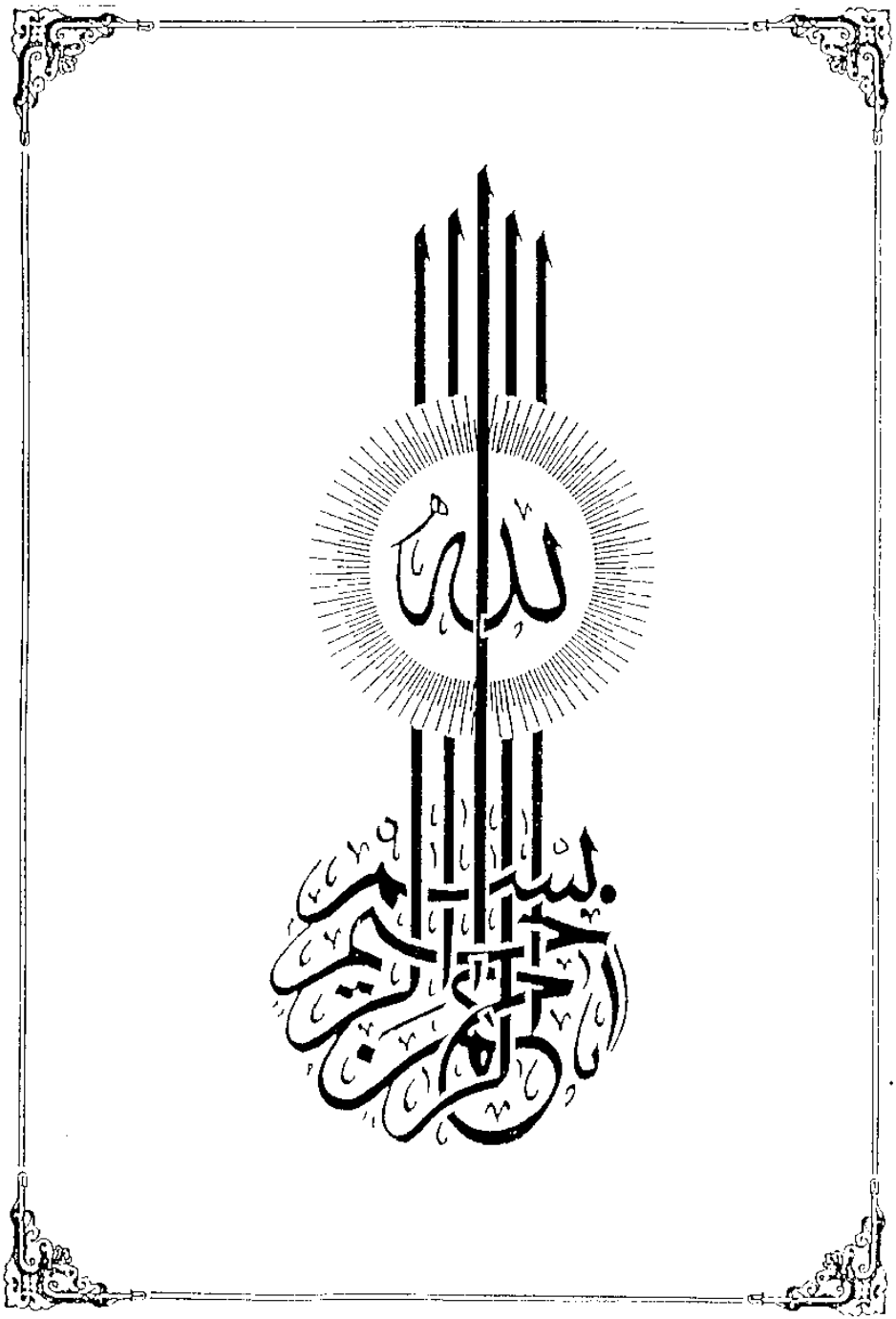

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CONTENTS

INTRODUCTION

Preservation of food by dehydration yields substantial economical aspects in transportation and storage especially for perishable commodities. The use of dynamic optimization procedures in food processing operation has been now extended and this is true particular by in dehydration. Several attempts have been made to optimize drying process with respect to minimizing drying time and/or energy costs; Bertin and Srour, 1980; Militzer, 1981, 1982b, 1982c). However, there are certain trials for improving product quality attributes such as color or nutrient retention as a function of drying.

There are a several drying schemes whereby a vegetable product, could be dried to a specified moisture content. The air flow rate and wet as well as dry-bulb temperature may be varied during drying with respect to the shape, size, orientation and loading of the vegetable product; Mishkin et al. (1984a).

Several deteriorative reactions that affect the colour, nutrient properties, texture and flavour of dehydrated products are usually initiated during processing and dehydration operations, and continue during storage

at a rate that is controlled by storage conditions. Processing steps such as blanching, post-blanching treatments and dehydration, are responsible for nutrient losses and the initiation of many undesirable changes that could occur in dehydrated samples.

Although the leaching of soluble solids during the pre-dehydration steps has been reported by many workers, little informations are available concerning the effect of leaching on the storage stability of dehydrated products. However, carotenoid pigments stability, lipid oxidation, non-enzymatic browning (NEB) and rehydration properties during dehydration and subsequent storage are of great importance in the openion of Baloch et al. (1977) for a chieving higher quality of dehydrated food stuffs. The present investigation was designed to study:

a) the drying kinetic of potats, carrot and green bean,
b) the rehydration characteristics of dried materials,
c) the relation between drying conditions and reheological properties of rehydrated samples.

REVIEW OF LITERATURE

PART I

GENERAL VIEW POINTS ON THE CHEMICAL ANALYSIS OF POTATO, CARROT AND GREEN BEAN

1. Carbohydrates:

Garrote et al. (1984) studied the losses of glucose in potato slices held in water at different temperatures as follows:

Temperature ^{o}C	Holding periods *in min*
25	20,60 and 90
45	10,20 and 50
55	5,10 and 20
65	3,10 and 20
85	2.5, 5 and 10

In general an increase of temperature produced a higher glucose loss, particularly between 55 and $65^{o}C$. In a potato slices of 4x 90 x 50 mm and after 20 min extraction, losses were 12.50, 14.55, 34.90, 50.39 and 63% at 25, 45, 55, 65 and $85^{o}C$ respectively. The estimated apparent diffusivity of glucose in potato was 8.20×10^{-10} at $65^{o}C$ and 12.50×10^{-10} m^2/s at $85^{o}C$.

Boruch et al. (1981) described the automatic control of potato starch drying by controlling the revolutions of a vacuum dehydrator. A special electronic Worm sensor was designed for the continuous determination of starch moisture content by conductivity. The influence of temperature on moisture determination was compensated in an electronic system by means of a thermistor. The automatic control system for starch drying operated in the range of 17-23% H_2O, with an accuracy of $\pm$ 0.3% H_2O.Cronin and Smith (1979) used a simple analytical scheme for the determination of reducing and total sugars as well as glucose, fructose and sucrose in aqueous methanolic extracts of potatoes by Somogi's micro-colorimetric Cu reduction method. Reducing and total sugars are calculated from the reducing power before and after inversion with hot diluted, HCl, and sucrose by difference. Fructose is estimated from the decrease in reducing power after complete removal of glucose with glucose oxidase. Results from potato extracts agree well with those obtained by the anthrone method.

The effect of different methods of potato drying on the properties of starch was investigated by Dudkin, et al.(1978).It was observed that in all cases drying significantly influenced the physicochemical properties and

the structure of starch; changes being to a great extent dependent on the individual potato variety. Drying that generally resulted in interactions between starch and protein lead to a significant starch degradation, an increase in the content of water soluble dextrins, decrease in starch molecular weight and viscosity as well as a noticeable reduction in its stability to the action of malt diastase.

2. Vitamin C:

Golynskaya, et al. (1980) studied the contents of water soluble vitamins in dried potato puree, and in dried potato product (Flakes, granules, powder). Vitamin C content of dried potato product (7.75-14.50 mg/100) was approximately 3 times higher than in the dried potato puree (3.38-5.81). The B group vitamins were more stable on heating and their contents were about the same in the dried potato products as in the potato puree. Amarfi (1980) published a mathematical modelling of changes in the ascorbic acid content of dried potato flakes during storage. The regression equations are given relating ascorbic acid degradation to storage time, storage temperature and moisture content of the flakes.

Mohammad and Ehteschamuddin (1973) studied the effect of blanching and sulphiting on ascorbic acid losses

during dehydration and storage of carrot, potatoes, turnips, caulifower, spinach, and fenugreek were examined. Optimum blanching time was ranged from 7 min. for potatoes and carrots (Complete peroxidase inactivation). Vegetables dried without pre-treatment lost 45.6-78.2% ascorbic acid. This loss was reduced to 16.6-29.4% by blanching and to 0.8-22.7% by blanching + sulphiting. The losses in total carotenoids and ascorbic acid were studied by Andreotti et al. (1980) during dehydro-freezing of dried carrots of 10 mm cubes under different conditions including: 1, 2, 3, 4 or 6 min. of preliminary blanching by hot water or steam; partial dehydration up to 85% weight loss and conventional freezing with liquid air at -50°C. Results revealed, that the best treatment was 3 min steam blanching and vacuum drying at 80°C. This produced the minimum loss of carotenoids and about 71% loss of ascorbic acid.

3. Carotenoids:

Darman'yan and Dudkin (1977)studied the effect of thermal dehydration on carotene, ascorbic acids, phenolic substances, different forms of N,amino acid,glucose,fructose, sucrose,pectinaceous substances and hemicellulose contents. They found,that during slow dehydration the intensity of oxidation processes increased due to the extended period of contact between the carrots and the atmospheric O_2. This was

responsible for loss of vitamins and phenolic substances. Increased temperature (i.e. accelerated drying) led to greater destruction. The optimal process is high temperature drying in a fluidized bed. The enzymic destruction of carotenoids in unblanched carrot tissue, incomplete extraction of pigments from raw carrot, thermal destruction of carotenoids by blanching and cooking of carrot, and leaching of soluble solids during processing of carrot were given by Baloch et al.(1977),as a possible explanations for apparent increases in carotenoid content during processing. They also found that the leaching of soluble solids was the major factor responsible for apparent increases in carotenoid when results were expressed on a water insoluble solids basis.B-carotene, the most biologically active carotene and the major pigment of carrot, was found to be about 1.9 times more susceptible to heat damage than α-carotene during normal blanching and cooking processes.

4. Peroxidase and polyphenol oxidase:

Carrot (Nantes cv.) was sliced by Baruffaldi et al. (1983) into 0.2 cm pieces, and blanched for 2, 4, 8 or 16 min. in water at 80, 92 or 96^{o}C, or steam at 97.8^{o}C, and cooled in phosphate buffer (pH 6.4) containing

20 p.p.m. ascorbic acid. The residual peroxidase activity of homogenates of the blanched samples was then evaluated and proved that 99.2% of peroxidase activity was destroyed after 16 min at 88°C, 99.4% after 4 min at 92°C, 97.7% after 2 min at 96°C, and 98.3% after 4 min at 97.8°C. Lee and Smith (1979) noticed that table beet polypehnol oxidase (PPO) causes undesirable color in underblanched products. The enzyme was most active at pH 7.0 and a temperature of 25°C. The rate of heat inactivation increases rapidly with increasing temperature and follows pseudo-first order kinetics. The enzyme activity varied among different cultivars of table beets. Water blanching deactivated the enzyme but the time required for a complete inactivation varied according to the size of table beets.

Baardseth and Slinde (1980) studied the heat inactivation and pH optima of the enzymes peroxidase and catalase in carrot, swede and brussels sprouts. There were differences in the heat stabilities of the peroxidase from different vegetables, but all peroxidase were more heat stable than the catalases. From the pH profiles and the heat stability curves it was concluded that both the peroxidase and catalases in the three vegetable species are

somewhat different. Birch and Green (1981) mentioned that peroxidase and catalase, which are widely distributed in plants, are considered to have an empirical relationship to off-flavours in some vegetables; (Svensson, 1977). A reduction of the activity of these enzymes in carrot, cauliflower and french bean by heat, increased the storage stability of these vegetable (Baardseth, 1978). Peroxidase appears to be the most heat stable enzyme in plants. For this reason peroxidase activity is widely used as an index of blanching. It has been generally accepted that if peroxidase is inactived it is quite unlikely that other enzymes will be active. However, complete inactivation of peroxidase has been shown not to be necessary for quality preservation in frozen vegetables (Bottcher 1975 a,b; Baardseth, 1978). It has been accepted as a general rule in the food industry that if there is activity of peroxidase, no catalase activity should be detected.