Effect of Coating with Starch and Nordihydroguaiaretic Acid on the Stability of Carotenoids of Dehydrated Carrot

A.K.BALOCH*, K.A.BUCKLE AND R.A.EDWARDS**

Department of Chemistry, Gomal University, D.I.Khan, Pakistan

**School of Food Technology, University of New South Wales, NSW (Australia).

(Received 22nd October, 1984)

Summary: The effect of coating carrot with starch and nordihydroguaiaretic acid (NDGA) on the stability of dehydrated carrot was investigated. The effectiveness of these coatings was evaluated by following changes in carotenoid content of dehydrated carrot during 420 days of storage at 37°C. Starch coating reduced carotenoid breakdown considerably and increased the storage life of dehydrated carrot to 123 days compared to 30 days for samples given a water treatment alone. The sotrage life was further enhanced to 237 and 420 days when coated with starch containing 0.03% and 0.3% NDGA respectively. However, high concentrations of NDGA caused discolouration and imparted an unpleasent taste and odour to dehydrated carrot during storage.

Introduction

Previous findings on the effect of chemical treatments on the stability of dehydrated carrot [1] prompted further studies to investigate the effect of coating carrot at elevated temperature with starch alone or in combination with nordihydroguaiaretic acid (NDGA) on the stability of carotenoids of dehydrated carrot. The application of NDGA in combination with starch was selected with the object of preventing lipid oxidation initiated on the surface of carrot dice and thus minimizing the possibility of carotenoid destruction.

Materials and Methods

Fresh carrots were sorted, trimmed, hand peeled and washed in running water. The carrots were diced (9.4 mm^2 x 3.1 mm) and thoroughly mixed to ensure complete uniformity of samples. Diced carrots were steam blanched for 5 min to inactivate peroxidase, and then divided into lots to be treated with starch (2.5 w/v) alone or in combination with 0.03% or 0.3% (w/v) NDGA.

A suspensions of starch alone or with NDGA was prepared by heating the chemicals suspended in distilled water at 77°C until formation of a transparent gel. Blanched carrots were immediately immersed into the hot suspension (0.9Kg/1) for 1 min at 77°C. To compare the effectiveness of the chemicals the carrots were also given a water dip treatment.

The treated carrots were drained, dehydrated and 20 g of dehydrated carrots were hermetically sealed into tinplate cans and incubated at 37°C. Samples were removed after 30,90, 180 and 420 days of storage, ground to pass a 20 mesh sieve and analysed for carotenoid content. The source

of carrots, the procedures for blanching of dice carrot, dehydration of blanced and treated carrots and the methods used for the determination of moisture content and carotenoid content have been reported in previous publications [1-4].

Results and Discussion

The rate of carotenoid loss was relatively rapid during the initial stages of storage, followed by a slow rate of loss at the end of the storage (Fig.1) as reported previously [1]. However, total carotenoid losses were considerably lower than those found in the earlier studies. In the present studies at least 75% carotenoids were retained by dehydrated carrot treated with starch and stored for 180 days at 37°C, whereas only 47.3% and 48.7% carotenoids were retained previously in samples treated at 25°C with the same concentration of starch and NDGA suspensions, respectively (Table-1).

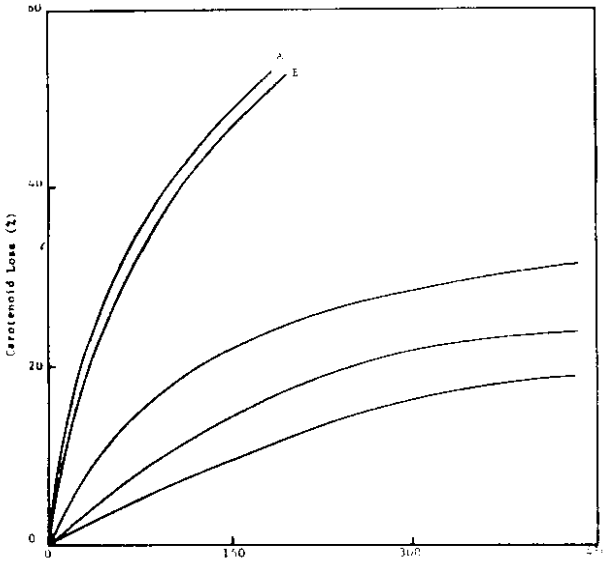

Fig.1: Effect of Starch and NDGA Coatings on Loss of Carotenoids of Dehydrated Carrot During Storage at 37°C.

Cold Suspension
A = 2.5% Starch
B = 0.03% NDGA

Hot Suspension
C = 2.5% Starch
D = 2.5% Starch containing 0.03% NDGA
E = 2.5% Starch containing 0.3% NDGA

Similarly starch alone or in combination with NDGA when applied as a hot suspension considerably increased the storage life of the dehydrated carrot compared to those treated with suspensions applied at room temperature. Storage life is expressed as days for 20% loss in carotenoid pigments when dehydrated carrots become unacceptable [5]. The storage life for carrots treated with starch and NDGA was 38 days and 35 days respectively when carrots were coated at 25°C, whereas it was increased by more than 3 times when the suspensions were applied at 77°C. in previous studies starch and NDGA applied at ambient temperature did not give carotenoid protection greater than that afforded by the water dip alone probably indicating unsatisfactory application of starch and NDGA which are insoluble in cold water. These observations show that dehydrated carrot coated with starch at 77°C was superior in preserving carotenoids in samples coated with both starch and NDGA at 25°C. It is obvious from these studies as well as from the appearnace of the uniform coating that the starch coating prepared in the present studies gave a better surface coverage and hence protected carotenoids more effectively by isolating oxygen from carrot as suggested by McCormick [6]. In the previous studies the starch suspension was applied at 25°C and did not provide a satisfactory coating, indicating the importance of the method of starch application.

NDGA applied at 77°C in combination with starch afforded protection to carotenoid pigments. The rate of

Table-1: Effect of starch and NDGA on the carotenoid content of dehydrated carrot during storage at 37°C.

Treatment	Temperature of the liquid for dip(°C)	Moisture Content (%)	Initial carotenoid content of dehydrated carrot (µg/g).	Carotenoids remaining (%) Storage time (days) 30	90	180	420
Cold starch* (2.5%) dip.	25°	3.9	945	82.6	60.5	47.3	-
Cold NDGA* (0.03%) dip.	25°	3.8	1210	82.7	62.6	48.7	-
Hot Water dip	77°	4.2	792	77.5	54.0	37.8	-
Hot starch (2.5%)dip	77°	4.2	836	93.8	84.0	75.0	68.4
Hot starch (2.5%) NDGA(0.03%)† dip	77°	4.2	835	96.2	90.6	83.1	76.2
Hot starch (2.5%)† NDGA(0.3%) dip	77°	4.1	830	98.0	94.1	88.7	81.1

*Resuls from Baloch et al. [1]

the former material encourages discolouration [1] and moreover it gives an unpleasent taste and odour which has also been reported by Musco and Cruess [7] in nut meats. Hence the use of NDGA at high concentration in dehydrated vegetables would appear to be limited even if its use was permitted by food regulations.

It appears that the use of starch with NDGA at low concentration is of great value in such dehydrated products, provided it is applied at an elevated temperature. Starch coatings for carrots are now in use commercially [8]. Since both NDGA, which interacts with oxygen, and a starch coating, which reduces the rate of diffusion of oxygen, resulted in greater retention of carotenoids during 420 days of storage at 37°C than in control samples, it is suggested that carotenoid oxidation of dehydrated carrot is initiated mainly from the exposed surface of carrot dice, and oxygen is the primary cause of carotenoid breakdown.

carotenoid destruction was considerably lower in carrots coated with starch containing 0.03% NDGA than in carrots treated with starch alone. It was further reduced when the concentration of NDGA in starch was increased to 0.3% (Fig.1). At the end of 420 days of storage at 37°C, 76.2% and 81.1% carotenoids were found in carrots coated with starch containing

Table-2: Effect of starch and NDGA on the storage life of dehydrated carrot at 37°C

Treatment	Storage life (days for 20% loss in carotenoid pigments).
Cold starch (2.5%) dip	38
Cold NDGA (0.03%) dip	35
Hot water dip	30
Hot starch (2.5%) dip	123
Hote starch (2.5%) + NDGA (0.03%) dip	237
Hot starch (2.5%) + NDGA (0.3%) dip	> 420

0.03% and 0.3% NDGA respectively compared to 68.4% carotenoid retention in samples coated with starch alone. The storage life was 123 days for carrots coated with starch alone and increased to 237 days for carrots coated with starch containing 0.03% NDGA (Table - 2). The storage life was even further prolonged to more than 420 days when the concentration of NDGA in the starch was increased to 0.3%.

Although 0.3% NDGA in starch was found to increase the carotenoid retention of samples by 1.7 times compared to those samples treaed under similar conditions with starch alone,

References

1. A.K.Baloch, K.A.Buckle and R. A.Edwards, *Pakistan J.Sci.Ind.Res.*, ***24***, *203 (1981)*
2. A.K.Baloch, K.A.Buckle and R. A.Edwards, *J.Fd.Technol.*, ***12***, *285 (1977)*
3. A.K.Baloch, K.A.Buckle and R. A.Edwards, *J.Fd.Technol.*, ***12***, *295 (1977)*
4. A.K.Baloch, K.A.Buckle and R. A.Edwards, *J.Chromatogr.*, ***139***, *149 (1977)*
5. R.G.Tomkins, L.W.Mapson, R.J. L.Allen, H.G.Wager and J.Barker, *J.Soc.Chem.Ind.(Trans)*, ***63***, *255 (1944)*
6. R.D.McCormick, *Food Prod.Devel.*, ***9***, *14 (1975)*
7. D.D.Musco and W.W.Cruess, *J.Agr.Food.Chem.*, ***2***, *520 (1954)*
8. B.Feinberg, Food Dehydration (AVI Publ.Co.Inc., Westport, Connecticut; W.B.Van Arsdel, M. J.Copley and A.I.Morgan, Jr. Eds) 2,1 (1973)