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Department of Defence
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Scottsdale, Tasmania

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The Effect of Variety on Quality After Dehydration of Onions (*Allium cepa*) (U)

G. E. DRIVER and S. VENKATA-RAMAN

August, 1977

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SUMMARY

Twelve onion varieties were analysed for total solids and pyruvic acid contents before and after dehydration. All varieties after hot air drying showed complete loss of pungency as determined by the allinase enzyme activity while freeze-dried samples retained enzymic activity one fifth to one half of fresh samples.

On the basis of these results, it is difficult to make firm recommendations based on chemical quality. However, tentative recommendations of varieties suitable for dehydration are made based on economics of cultivation and processing. (U)

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CONTENTS

THE EFFECT OF VARIETY ON QUALITY AFTER DEHYDRATION OF ONIONS (Allium cepa)

by

G. E. Driver and S. Venkata-Raman

INTRODUCTION

Onions are a component of several freeze-dried composite meals produced at the Armed Forces Food Science Establishment (AFFSE), and make up a large proportion of the net weight of freeze-dried "Steak and Onions". Dehydrated onions are also used as a component of the "Potato and Onion Powder" for Papua/New Guinea rations. Current practice is to use commercially available dehydrated onions because of convenience and economies in production.

Badcock (1968) in a study of the suitability of onion varieties for dehydration found that Dehydrator 14, Spanish Imperial White and White Granite were preferable to Cream Gold on the basis of higher total solids and pyruvic acid contents. Fairbrother (1968) reported that Pukekohe was more suitable than White Imperial Spanish, Selections 306 and 307, Riverina Late Brown and Brown Spanish.

During the growing season 1973-74, a variety trial was conducted at the Forthside Vegetable Research Farm of the Tasmanian Department of Agriculture, and samples from this study were made available to AFFSE.

EXPERIMENTAL METHODS

Onions were kept in cool storage until peeled and diced by hand to approximately 10 mm cubes. Samples were removed for analyses of total solids and pyruvic acid and the remainder frozen until dried.

Pyruvic Acid Content

Onions were analysed for pyruvic acid content essentially by the method of Schwimmer and Weston (1961). Fresh onion and water (1:1) were macerated and after ten minutes, trichloroacetic acid (5 g) was added to 5 g of slurry, the mixture filtered with the aid of celite and made to 800 ml with water.

Dried onions were ground with pestle and mortar and 1 g added to 10 g water, the solution being made up to 100 ml after filtration. Non-enzymatically produced pyruvic acid was determined by rehydration of 1 g dried onion with 10 ml of 0.1 N hydrochloric acid.

Colour development was as described by Schwimmer and Weston (1961).

Dehydration

The frozen diced onions from duplicate plots were bulked and redivided for freeze-drying and hot air drying. Freeze-drying was carried out in a Vickers Pilot Plant using radiant heating with maximum plate temperature of 50°C, and a pressure of less than 0.1 Torr. Drying took twenty nine hours which included twelve hours overnight when platten heating was discontinued.

Hot air drying in an experimental cross-flow dehydrator was carried out at 60-80°C for 7½ hr followed by overnight drying at 30°C.

Moisture and Total Solids

Moisture and total solids were determined by vacuum oven drying at 67°C overnight.

Organoleptic Testing

Dehydrated onions were rehydrated in simmering water for twenty minutes, and freeze-dried onions by soaking in cold water for fifteen minutes. A panel of five AFFSE staff members rated the rehydrated onions on a 9 point scale for flavour and overall acceptance (9—like extremely, 1—dislike extremely) and appearance and pungency (9—extremely good or pungent, 1—extremely poor or weak pungency).

RESULTS AND DISCUSSIONS

Fresh Onions

Analyses of fresh onions are shown in Table 1. Solids content ranged from 11.0 to 18.5%, most samples falling in the range 12-14%. These values are not high, the American processing industry preferring values at least as high as 15%, but preferably up to 20% (Reynolds, 1959; Van Ardsel and Copley, 1964). The Australian industry is not able to grow crops to this solids content. Hybrid Ivory (New World), Cultivar J, had the highest solids content of 17.4 and 18.5% for replicate plots and would be preferred on this basis.

Pyruvic acid contents based on fresh weight and per solids basis, are shown in Table 1. All onion cultivars tested were high pungency varieties, and there is little to choose between varieties on this basis, especially in view of loss of pungency on dehydration as will be shown later. Hybrid Ivory and Early Globe (Porters) had average pyruvic acid contents on a fresh basis, but had low and high contents on a solids basis because of their respective high and low solids contents of 18.0 and 11.0%.

Hot Air Dried Onions

Pyruvic acid contents of dehydrated onions are shown in Table 2, pyruvic acid produced as a result of enzymic activity due to allinase (P_E) being the difference between total (P_T) and control (P_C) values.

From the low, often negative, values of P_E for dehydrated onions it is apparent that all pyruvic acid present was formed before reconstitution. The dried onions therefore have little of the pungency typical of fresh onions.

Local selection ET and Hybrid Ivory gave a slightly darker product than other varieties, the latter having a definite pink colour. This would be a disadvantage in drying, but colour differences are only discernible on direct comparison of dried material, and were not noticed by the taste panel during tasting of the rehydrated material.

Taste panel results for dehydrated onion varieties are shown in Table 3. Analysis of Variance using Judge x Variety interaction as an estimation of error indicated that differences between varieties were not significant.

It would seem to matter very little which onion variety is used for dehydration as little enzymatic activity is left. Hybrid Ivory with its high solids content must therefore be the first choice. In commercial processing, maximum temperatures during drying are usually limited to 60°C which may give a product its residual allinase activity.

Pungency may also have been reduced by freezing prior to drying, as Freeman and Whenham (1974) found that freezing at −20°C for 1 hr greatly decreased odour, pungency and the lachrymatory potency of onions.

Large variations in solids and pyruvic acid content with growing condition have been reported. Freeman and Mossadeghi (1973) found that water regimen could affect onion flavour strength by a factor of five fold and sulphur nutrition, in a laboratory situation, may have a twenty fold effect (Freeman and Mossadeghi, 1970). It may be expected that varieties may behave differently to water regimen, sulphur nutrition and season, thus affecting results greatly.

This is possibly exemplified by the results of Badcock (1968) and Fairbrother (1968) as shown in Table 4. On the basis of higher total solids and total pyruvic acid contents, Badcock recommended White Imperial Spanish for dehydration in preference to Cream Gold which was stated to be similar to Pukekohe. Fairbrother found Pukekohe to be better than White Imperial Spanish in both these respects.

The present experiment also shows large variations in solids and pyruvic acid contents between replicates of one variety. Because of these large variations it is difficult to compare experiments or to say that one variety is preferable after a single experiment. However, during the 1973-74 growing season, Hybrid Ivory had the highest solids content of varieties tested and is therefore to be preferred. The small differences in pyruvic acid contents between varieties tested, coupled with large differences between replicates and the negligible enzymatic production of pyruvic acid on rehydration of dehydrated onion, makes any comparison of varieties on this basis pointless and may make comparison of yield/acre on fresh or solids basis a deciding factor. Based on yield data (Table 5) Hybrid Ivory however would appear to be the least economical of the cultivars under the experimental growth conditions. Selection 7 gave the highest yield, a large proportion of which was of size greater than 50 mm.

Freeze-Dried Onions

Freeze-dried onions had higher values for P_T and lower values for P_C than hot air dried onion, values obtained being shown in Table 5. Freeze-drying being a more gentle process does not completely destroy enzymatic activity responsible for flavour formation. Values for P_E (or $P_T - P_C$) were typically one fifth to one half that of fresh onions.

P_E values of freeze-dried onions seem to bear little relationship to initial values present in fresh onions. Reasons for some cultivars retaining enzymatic activity must be in either slightly differing rates of denaturation of enzymes responsible for flavour development or be an artifact of this experiment. This last may be true as onions of the same variety from different seed houses gave very different results. For example cultivars L, M and N all variety Cream Gold, from three different seed sources, had P_T values of 221, 202 and 200 before drying, and P_E values of 68, 114 and 80 after freeze-drying. These P_E values represent 31, 56 and 40% of the corresponding P_T values for the fresh onion variety.

The taste panel results indicated that freeze-dried onion was soft and soggy, unlike raw fresh onion which is crisp. They also had milder flavours, but still retained pungency and would be suitable for salads, where the onion is finely divided so that texture defects are not noticeable but pungency is desired.

Taste panel results are shown in Table 6, and analysis of variance using the Judge x Variety interaction as an estimate of error indicated that only scores for flavour showed any significant difference between varieties.

If freeze-dried onions are intended for consumption uncooked the varieties of choice would be Selection 7, Cream Gold Early Maturing or Cream Gold (Yates, Australia). The differences in pungency however are only small. Hybrid Ivory may also be recommended because of its high solids content, although the taste panel gave it a significantly lower score for flavour than the three varieties recommended above.

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Table 1 **Total solids content and total pyruvic acid contents of onion varieties**

Variety	Source	Designation	Plot 1			Plot 2		
			Solids (%)	P_T μ mol/g fresh wt	P_T μ mol/g dry wt	Solids (%)	P_T μ mol/g fresh wt	P_T μ mol/g dry wt
Selection 2	Local	B	12.8	32.4	253	11.5	31.7	276
Selection 5	Local	C	13.0	29.0	223	11.9	29.7	250
Selection 7	Local	D	12.9	30.8	239	12.3	28.5	232
Selection ET	Local	E	14.2	32.0	225	13.1	29.6	226
Pukekohe	Winstons	F	13.8	29.7	215	12.9	29.3	227
Early Globe (Porters)	Winstons	G	11.0	34.7	315	11.0	26.8	244
Pukekohe L.K. (MOR)	Coopers	H	13.7	23.8	174	13.2	30.0	227
Hybrid Ivory	New World	J	18.5	29.0	157	17.4	27.4	157
C.C. Early Maturing	Hendersons	K	14.2	24.3	171	13.9	27.3	196
Cream Gold	Hendersons	L	13.5	26.3	195	12.7	28.1	221
Cream Gold	New World	M	13.6	22.6	166	13.0	26.2	202
Cream Gold	Yates (Aust.)	N	13.7	24.7	180	13.2	26.4	200

Table 2 **Pyruvic acid contents of dehydrated onions**

Variety	Pyruvate (μ mol/g dry wt)		
	P_T	P_C	P_E
B	73	87	−14
C	82	82	0
D	80	68	12
E	78	90	−12
F	66	70	4
G	84	82	2
H	74	69	5
J	62	77	−15
K	66	64	2
L	74	65	9
M	65	65	0
N	64	77	−13

Table 3 **Taste Panel scores for dehydrated onion**

Variety	Average Score[a]			
	Appearance	Pungency	Flavour	Overall Accept-ability
B	5.8	4.5	4.3	4.5
C	6.0	5.3	4.3	4.8
D	5.5	5.3	4.8	5.3
E	5.8	5.3	4.8	5.3
F	5.8	5.0	5.3	5.3
G	4.8	4.8	4.0	4.0
H	5.0	5.3	5.3	5.3
J	5.3	5.3	5.0	5.0
K	6.3	5.3	5.5	5.5
L	5.5	5.5	5.5	5.5
M	5.8	5.5	5.8	5.8
N	5.8	5.0	5.5	5.3

(a) Average of tasters, on hedonic scale 1 – extremely poor, 9 – excellent.

Table 4 **Pyruvic acid contents and solids contents of onion varieties**

Variety	Fairbrother[d]		Badcock[e]		Present	
	P_T[a]	Solids[b] (%)	P_T[a]	Solids[e] (%)	P_T[a]	Solids[c] (%)
Pukekohe	15.8	15.2	–	–	29.3 – 29.7	12.9 – 13.8
Cream Gold	–	–	9.7	12.35	22.6 – 28.1	12.7 – 13.7
Spanish Imperial White	12.0	12.0	10.4	14.25	–	–

a Total pyruvic acid content μ mol/g fresh weight.

b Soluble Solids on fresh material.

c Total Solids in fresh material.

d Fairbrother (1968).

e Badcock (1968).

Table 5 **Yield Data of Onion Cultivars***

Variety	Yield (Tonnes/ha)		
	Total	Size over 50 mm	% > 50 mm/ total
B	63	47	74.6
C	59	47	79.7
D	72	60	83.3
E	50	35	70.0
F	66	56	84.8
H	63	50	79.4
J	50	30	60.0
K	60	47	78.3
L	66	54	81.8
M	66	54	81.8
N	62	50	80.6

Table 6 **Pyruvic acid contents of freeze-dried onions**

Variety	Pyruvic acid content (μ mol/g dry weight)		
	P_T	P_C	P_E
B	107	53	54
C	113	58	55
D	158	59	99
E	133	57	76
F	113	42	71
G	136	58	78
H	111	35	76
J	117	55	62
K	128	33	95
L	114	46	68
M	156	42	114
N	131	51	80

Table 7 **Taste Panel scores of freeze-dried onions**

Variety	Average Taste Panel Score[a]			
	Appearance	Pungency	Flavour	Overall Acceptability
B	6.8	5.4	6.4[b]	6.2
C	6.8	5.4	6.0[b]	6.0
D	6.8	5.4	5.8[b,c]	6.0
E	6.6	5.4	6.2[b]	6.0
F	6.4	5.6	6.0[b]	6.0
G	6.2	5.5	5.6[b,c]	5.6
H	6.4	5.0	5.6[b,c]	5.6
J	6.8	5.4	5.0[c]	5.2
K	6.6	5.8	5.8[b,c]	6.2
L	6.4	5.6	5.8[b,c]	5.8
M	6.4	5.6	5.6[b,c]	5.6
N	6.2	6.0	5.2[c]	5.6

* Yield data kindly provided by Mr. B. Beattie of Tasmanian Department of Agriculture.

a Average of tasters, rating on 9 point hedonic scale
1 – extremely poor, 9 – extremely good.

b,c Figures with different superscripts are significantly different, (α = 0.05, Duncan's New Multiple Range Test).

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