Pak. j. sci. ind. res., vol. 36, nos. 1-2, Jan.-Feb. 1994

STUDIES ON STORAGE OF POTATO TUBERS WITH SPECIAL REFERENCE TO SWEETENING PROCESS

NAWAB KHAN, RASHIDA ZAMAN AND A. F. M. EHTESHAMUDDIN

PCSIR Laboratories Complex, Lahre-54600, Pakistan

(Received December 31, 1990; revised June 5, 1993)

Effect of storage temperatures and chemical treatments on accumulation of sugars in potato tubers during storage was studies. At regular intervals throughout the storage period, samples were analysed for reducing and non-reducing sugars. Storage at low temperature (4-5°) resulted in accumulation of more reducing and non-reducing sugars than storage at 12-14°. Whereas reducing sugar increased rapidly during storage at low temperature, rapid increase in reducing sugar was observed after about 2 months in tubers stored at 12-14°. Treatment with sodium acetate solution proved very effective in retarding the sweetening process. Accumulation of sugar in sodium acetate treated tubers was 50% less than in untreated samples. Treatments with sodium meta sulphite, potassium sorbate and hydrogen peroxide were not as effective in reducing the sweetening process.

Key words: Storage, Potato, Sweetening.

Introduction

Potato tubers are one of the most highly consumed vegetables in Pakistan all the year round. To stabilise its supply to the market in the off season, the surplus tubers in the glut season are stored in cold storage. It is a common observation that potato tubers become sweet in taste on storage and the degree of sweetening varies with the storage conditions, particularly temperature [1-6]. The sweet potatoes loose their eating qualities and industrial use. The inter-action of reducing sugars and nitrogenous compounds also favours the development of off-flavours and colour [7].

The present paper related to the study of storage temperatures and treatments with certain food additives on accumulation of sugar in a Pakistan cultivar of potato tubers during storage.

Experimental

Procurement of potato tubers. New crops of potato tubers *Solanum tuberosum* L. (pink skin variety, localy known as Altumush) were available in late December or early January. Forty kilograms of medium sized potato tubers weighing 60-100 g each were purchased from the market towards the end of December for the study. Blemished and small-sized tubers were discarded.

Tubers storage and sampling procedure. Unblemished tubers were dipped in water to remove adhering soil and dried under fan. Five kg of the tubers packed in Gunny-bags (Jute fibre bags) were stored at 4–5° and 12–14° and 85–90% r.h. (relative humidity). Changes in reducing and non-reducing sugars were determined after monthly intervals.

Chemical treatments. Sodium acetate, potassium sorbate sodium *meta*-bisulphite and hydrogen peroxide (technical grade) were used to observe their impact on the metabolite levels in the tubers during storage. These chemicals find extensive use in food industry to improve the quality of food products [8]. Five kilograms of potatoes were dipped for 24 hrs in ten liters of one percent acquous solution (w/v) of each chemical. The control sample was dipped in water for the same period. The tubers were taken out from the solution dried under fan, packed in Gunny-bags and stored at 12-14° and 85-90% r.h. Reducing and non-reducing sugars were estimated before and after dipping in chemical solutions and subsequently at regular intervals during storage.

Chemical analysis of potato tubers. All chemicals used for analysis were of analytical grade. Percent protein, moisture, fat, crude fibre, starch and ash were estimated according to AOAC [9] methods. Reducing and non-reducing sugars were estimated by Lane and Eynon [10]. The results of reducing and non-reducing sugars were expressed in milligrams per gram (mg/gm) of potato tuber on moisture-free-basis (M.F.B.). The results quoted in each table are the average of two studies conducted during two seasons. Duplicate readings were taken for each determination

Discussion

The results listed in Table 1 regarding chemical composition of potato tubers indicate that the variety under study is reasonably good for processing owing to low sugar content and fairly high quantity of total solids.

The effect of storage temperatures on the sugar content of potatoes are presented in Table 2. Storage temperatures had remarkable effect on the sweetening process in potato tubers.

Accumulation of reducing and non-reducing sugars was greater in tubers stored at (2-4°) than those stored at higher temperature. In the first two months, the reducing sugars in samples stored at 4-5° increased quite rapidly from 8 mg at 0 storage time to 32.5 mg/g after 2 months. In contrast, the reducing sugars in samples stored at 12-14° increased to 12.4 mg during the same period. That is, the metabolite level in the tubers stored at 2-4° was 2.5 times more than in the tubers stored at 12-14°, at the end of 2 months. During further storage, however, the ratio of the metabolite levels in the two samples declined gradually and the sugar level in samples of low temperature was only 1.3 times higher than the samples stored at 12-14°. Similar trend of the sugar accumulation was observed by Hart, *et al.* [1] in Pentland Dall tubers stored at 5 and 10°. The non-reducing sugar increased slowly but steadily during six months storage at 2-4°. In case of samples, stored at higher temperature the non-reducing sugar showed a slight increase, in the early two months then a decline occured during subsequent storage period. The effect of various chemical treatments on sweetening is discussed separately.

Sodium acetate. The results of the effect of sodium acetate treatment on sweetening process are presented in Table 3. The treatment reduced to accumulation of both reducing and non-reducing sugars in the tubers during storage at 12-14°. Reducing sugars increased from 5.6 mg to 79 mg in the treated potato tubers in span of six month. In comparison, the sugars in the un-treated samples increased to 148.3 mg under identical storage conditions during the same period (Table 2). Non-reducing sugar was also less in the treated samples. Total sugar content was nearly 50% less as compared to the control sample. Conversion of starch to sugar is a process catalyzed by enzymes. Any treatment which affects the enzymes affects the process. In this case sodium acetate treatment slows down the enzyme activity. There is, however, a need for further study to determine the exact mode of action or specify the enzyme(s) affected by the treatments.

TABLE 1. PROXIMATE CHEMICAL COMPOSITION OF POTATO TUBERS.

Constituents	Percentage
Moisture	76.5
Total solid	23.5
Fat	0.08
Carbohydrates	20.57
Crude fibre	0.45
Reducing sugar	0.24
Non-reducing	0.17
Total sugar	0.41
Starch	19.71
Proteins	1.8
Ash	1.05

Sodium metabisulphite. The results of sodium metabisulphite on potato sweeteing are presented in Table 4. The reducng sugar increased from 4.3 mg to 138.2 mg in six months storage of potato tubers. Non-reducing sugar showed a decrease from 2.3 mg to 0.6 mg during the same storage period. There was little difference in sweetening of sodium metabisulphite treated and control samples of potato tubers.

Potassium sorbate. The results of potassium sorbate treated tubers are presented in Table 5. The reducing sugars increased from 5–135 mg during six months storage period. Untreated (control) also accumulated 148.2 mg reducing sugar

TABLE 2. EFFECT OF STORAGE TEMPERATURE ON THE SUGAR* CONTENT OF POTATO TUBERS.

Storage period (in month)	12 - 14°		2 - 4°	
	Reducing sugar	Non-reducing sugar	Reducing sugar	Non-reducing sugar
0	8.0	5.6	8.0	5.6
1	9.3	8.0	13.6	10.0
2	12.4	7.2	32.5	11.2
3	29.6	6.5	51.3	12.3
4	67.3	5.0	97.0	13.6
5	127.0	2.6	140.5	16.0
6	148.0	1.2	194.0	18.0

* mg per gram on moisture-free-basis.

TABLE 3. EFFECT OF SODIUM ACETATE ON SUGAR* CONTENT OF POTATO TUBERS STORED AT 12-14°.

Storage period (in month)	Reducing sugar	Non-reducing sugar	Total sugar
Before dipping	8.0	5.6	13.6
After dipping	5.6	2.5	8.1
1	10.5	4.5	15.0
2	13.6	4.0	17.6
3	28.3	3.0	31.3
4	44.0	2.0	46.0
5	64.2	1.3	65.5
6	79.0	0.5	79.5

* mg per gram on moisture-free-basis.

TABLE 4. EFFECT OF SODIUM META-BISULPHITE ON THE SUGAR* CONTENT OF POTATO TUBERS STORED AT 12 - 14°.

Storage period (in month)	Reducing sugar	Non-reducing sugar	Total sugar
Before dipping	8.0	5.6	13.6
After dipping	4.3	2.3	6.6
1	8.5	6.5	15.0
2	10.2	5.2	15.4
3	26.5	3.3	9.8
4	54.0	2.0	56.0
5	116.3	1.2	117.5
6	138.2	0.6	138.8

* mg per gram on moisture-free-basis.

in six months storage period. There is no difference in the chemical treated and untreated samples.

Hydrogen peroxide. The results of reducing sugar and non-reducng sugars of hydrogen peroxide treated samples are presented in Table 6. Hydrogen peroxide also proved ineffective in reducing the sweetening proess in potato tubers. The increase in reducing sugar was similar to control samples.This chemical also bleached the skin of potato tubers.

TABLE 5. EFFECT OF POTASSIUM SORBATE ON THE SUGAR* CONTENT OF POTATO TUBERS STORED AT 12 - 14°.

Storage period (in month)	Reducing sugar	Non-reducing sugar	Total sugar
Before dipping	8.0	5.6	13.6
After dipping	5.0	2.0	7.0
1	11.5	6.0	17.5
2	16.6	4.6	21.2
3	30.0	3.5	33.5
4	58.3	2.6	60.9
5	120.5	1.6	122.1
6	135.0	1.0	136.0

*mg per gram on moisture-free-basis.

TABLE 6. EFFECT OF HYDROGEN PEROXIDE ON THE SUGAR* CONTENT OF POTATO TUBERS STORED AT 12–14°.

Storage period (in month)	Reducing sugar	Non-reducing sugar	Total sugar
Before dipping	8.0	5.6	13.6
After dipping	6.0	2.0	8.0
1	10.5	7.0	17.5
2	18.3	4.5	22.8
3	31.6	4.0	35.6
4	61.5	2.5	64.0
5	103.3	1.6	104.9
6	141.5	1.0	142.5

* mg per gram on moisture-free-basis.

It was concluded from study that all chemical treatments except sodium acetate proved ineffective in controlling the sweetening process in potato tubers during storage. Sodium acetate treated potatoes showed a reduction of 50% sugar accumulation during storage as compared to control and then chemical treated samples.

References

1. P. M. C. Hart, K. E. Pallett and A. H. Cobb, Applied Biology, **13**, 457 (1986).
2. N. S. Kapur, P. B. Mathur and K. P. Singh, Indian J. Hort., **9** (4), 30 (1952).
3. N. S. Kapur, P. B. Mathur and K. P. Singh, Bull. Control Fd. Tech. Res., India. Mysore, **2**, 42 (1952), Vide. Chem. Abst., **47**, 9519V.
4. P. B. Mathur, J. Sci. Ind. Res., **10** (9), 224 (1951).
5. B. Samotus, Potato Res., **14** (2), 145 (1971).
6. M. Tishel and M. Mazelis, Phyer Chem., **5**, 895 (1966).
7. T. J. Fuller and J. C. Hughee, J. Fd. Techn., **19**, 455 (1985).
8. N. Khan, R. Zaman and A. F. M. Ehteshamuddin, Pak. j. sci. ind. res., **32** (11), 772 (1989).
9. *Official Methods of Analysis* (Association of Official Agricultural Chemists Washington, D.C., 1965), 10th ed.
10. J. H. Lane and L. Eynon, J. Soc. Chem. Ind., **42**, 32 (1923).