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Effect of storage methods on solanine content of potato tubers

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Abstract
The effect of storage conditions namely heap, rack, ventilated bin and cold store varieties were studied. In the storage period of 120 days the change in solanine content in potatoes was determined for two popular varieties of potato namely Kurfi Jyoti and Kurfi Giriraj. The initial solanine content of Kufri Jyoti and Kufri Giriraj were found to be 2.2 mg/100 g and 5.3 mg/ 100 g respectively. The final solanine content per 100 g of Kufri Jyoti variety potatoes were 25.4 mg/100 g; 23.9 mg/100 g; 20.5 mg/100g; 13.2 mg/100 g respectively under heap, rack, ventilated bin and cold storage trials. For Kufri Giriraj variety, the solanine content measured were 30.5 mg/100 g; 28.2 mg/100 g; 23.5 mg/100 g and 20.9 mg/100 g respectively in the above said storage conditions. The results confirm that the glycoalkaloids content has been affected significantly by the storage methods and variety. It appears that solanine content formation is reduced if the potatoes are stored in dark.

Keywords: Storage method, ventilated bin, solanine content and glycoalkaloids

1. Introduction
Potato (*Solanum tuberosum* L.) is one of the most important staple crops for direct and processed consumption. It provides a good source of carbohydrates, high quality protein, fibre, low fat and vitamins, thus it has an important role in human nutrition. Consumer acceptance of potato is influenced by flavour, taste, texture and colour. Besides the presence of other biologically active metabolites such as calystegine alkaloids, protease inhibitors, lectines, phenolic compounds and chlorophyll, potato also possesses some naturally occurring toxic compounds called glycoalkoids (Nema, 2008) [1]. Glycoalkaloids are compounds containing nitrogen, which naturally occur in the members of Solanaceae or Nightshade family such as potato, tomato, eggplant, sweet pepper, nightshade, thorn apple, and tobacco. Glycoalkoids play an important role in the natural defense mechanism against some organisms like fungi, insects, viruses and herbivores (Ferreira, 1999) [2]. In addition, it has been reported that glycoalkaloids have caused illness and even death in people, livestock and farm animals (Thomson and Sporns, 1995) [3]. The higher contents of glycoalkaloids found in potatoes has affected their tastes positively (Abell *et.al*, 1996) [4]. When the amount of glycoalkoids reaches 15 mg/100 g fresh weight, a bitter taste occurs (Brajesh *et.al*, 2016) [5]. It was stated that the safe upper limit for human consumption is 20 mg glycoalkoids/100 g fresh weight for the table purpose. The potato contains two glycoalkoids namely □-solanine and □-chaconine which occur together and are usually discussed under single heading 'Solanine'.
In potatoes there are two major glycoalkaloids, α-chaconine and α-solanine, both triglycosides of the common aglycone solanidine. These two compounds comprise about 95% of the glycoalkaloids present in potato tubers. Their hydrolysis products β, γ forms and solanidine, may also be present, but in relatively insignificant concentrations. Wild-type potatoes can contain a greater diversity of glycoalkaloids (Kozukue *et.al.,* 1999) [6].
The moderately minor change in concentration from 'normal' to 'toxic' means that potatoes must be handled carefully after harvest for mechanical damages, temperature stress or exposure to light, because all of these can activate the solanine synthesis. Potato skin contains the maximum concentration of solanine, peeling can prove beneficial but any subsequent exposure of the peeled potatoes to light can lead to renewed synthesis of the alkoids. Although the total glycoalkoids content of potato tubers were genetically controlled, the levels found at harvest are strongly influenced by environmental effects during the growing season (Friedman, 2003) [7]. Additionally, postharvest treatments may significantly increase tuber glycoalkoids content. In particular, exposure to direct sunlight (Percival *et al.,* 1996) [8] or artificial light increases glycoalkaloids concentration with the magnitude of the observed increase being cultivar-dependent (Griffiths *et al.,* 1994) [9]. Bruising and impact damage during harvesting and grading also increase glycoalkoids levels in tubers with significant differences being found

between cultivars. The objective of this study was to determine the effects of different storage methods on solanine content for two different varieties namely Kufri Jyoti and Kufri Giriraj of potato grown in Nilgiris District, of Tamil Nadu.

2. Material and Methods

The study was conducted in the Palada village in Nilgiris District in 2018. Potatoes of medium size and uniform shape were selected from each variety in order to limit the variations from size differences. After natural curing, 5 kg of potato tubers from each variety were stored under four different storage methods namely heap, rack, ventilated bin and cold store. The study was carried out for a period of 4 months (15.09.2018 to 15.01.2019) to investigate the effect of storage methods on solanine content. The triplicate samples were taken at an interval of 10 days for the analysis from each storage methods.

2.1 Heap Method: It is the traditional method followed by the farmers of the Nilgiris where the potato tubers were heaped under shade but there will be an indirect sunlight intrusion on the potato. The temperature maintained in the above storage was 20-22 °C.

2.2 Rack Method: In this method, the potato tubers were placed in the wooden rack inside the room, where the sunlight diffusion is less compared to heap. The room was ventilated by means of natural ventilation. The temperature maintained was 15-20 °C.

2.3 Farm Level Ventilated Bin: The night time air alone was ventilated in order to maintain low temperature inside the bin and it was ventilated by means of a blower. The temperature maintained in the bin holding tubers was around 10-15 °C. In bin storage, the top layer of tuber alone was exposed to minimum light from the atmospheric condition.

2.4. Cold Storage: The potato tubers were kept in the Sree Saravana cold storage in Mettupalayam, Tamil Nadu and temperature was maintained at 2 °C.

2.5 Solanine Estimation Method

A 10 g sample of diced potato tuber was macerated with the pestle and mortar in acidified alcohol (96% ethanol with 5% acetic acid) for 10 min. After filtering through whatman No.1 filter paper, the filtrate was heated in a water bath at 70 °C for 30 min. On cooling, ammonium hydroxide was added until the pH of filtrate reached 10 and the glycoalkaloids precipitated. The filtrate was centrifuged at 5000 rpm for 5 min and the precipitate was washed with NH_4OH (N/100). After recentrifugation, the precipitate of cured glycoalkoids was dried to constant mass. Taking the molecular weight of solanine as 868, glycoalkaloids was dissolved in a mixture (1:1) of 96% ethanol and 20% H_2SO_4 to give a concentration of alkaloids of 0.2-0.3 mM. From this latter solution, duplicate aliquots (1 ml) were mixed with 5 ml of 60% H_2SO_4 and after 5 min, 5 ml of formaldehyde (0.5% in 60% H_2SO_4) were added. After standing for 3h, the absorbance of the test solution was measured at 560-570 nm using a spectrometer (Haddadin *et.al*, 2001) [10]. The total level of glycoalkoids was recorded as solanine equivalent (mg/100 g fresh weight) by reference to a standard curve of pure solanine.

In the study, four different storage types (heap, rack, ventilated bin, cold store), 13 different storage periods (10 days of interval for 4 months of storage) and two varieties (Kufri Jyoti and Kufri Giriraj) were selected as experimental factors. The analysis was carried out according to completely randomized blocks design with three replications. The AGRESS statistical tool was used to analyze the data.

3. Results and Discussion

The effect of storage method on solanine content of Kufri Jyoti and Kufri Giriraj for a storage period of 120 days was presented in the Fig. 1 and Fig. 2. from the results it was confirmed that the Kurfi Giriraj showed higher solanine content than Kurfi Jyoti variety. There was an increase in solanine content from 0^{th} day to 120 days of storage period with respect to all storage methods and varieties. In heap storage, for Kufri Jyoti variety, the solanine content changed from 2.2 mg/100g at the 0^{th} day to 25.4 mg/100 g after 120 days of storage. In rack storage, solanine content was 2.2 mg/100 g on 0^{th} day and after 120 days of storage period it was 23.9 mg/100 g. In ventilated bin, on 0^{th} day solanine concentration was 2.2 mg/100 g and after 120 days of storage it was recorded as 20.5 mg/100g. In cold storage, solanine content on 0^{th} day was 2.2 mg/100 g and it increased to 13.2 mg/100 g.

In Kufri Giriraj variety, the initial solanine content was 5.3 mg/100 g after 120 days of storage and it increased to 30.5 mg/100g in heap storage, 28.2 mg/100 g in rack storage, 23.5 mg/100 g in ventilated bin storage and 20.9 mg/100 g in cold storage. In all the storage methods, there was a significant difference at the level of (P<0.01). The result confirms that there was a negative effect with increase in temperature and light on solanine content of the potato during storage.

Similar results were reported by the Percival (1999) [11] in which he stated that the low storage temperature (4 to 5 °C) leads to slower accumulation of glycoalkaloids in tubers than at high storage temperature (21 to 25 °C), but glycoalkoids concentrations can greatly fluctuate during storage. Greening of tubers will occur when exposed to light, that often results in higher glycoalkaloids concentration. Van Gelder (1991) [12] stated that the rate of greening as well as glycoalkoids accumulation is cultivar dependent and is slower at a low temperature. Kaaber (1993) [13] reported that formation of glycoalkoids is faster and higher levels are reached in daylight compared with fluorescent light. Generally, under illumination the increase in glycoalkoids was greater in immature and small tubers than in mature and large tubers. Mechanical injury stimulates glycoalkoids synthesis in the whole tuber and not just in the damaged part. Synthesis of solanine proceeds more slowly in cooler conditions.

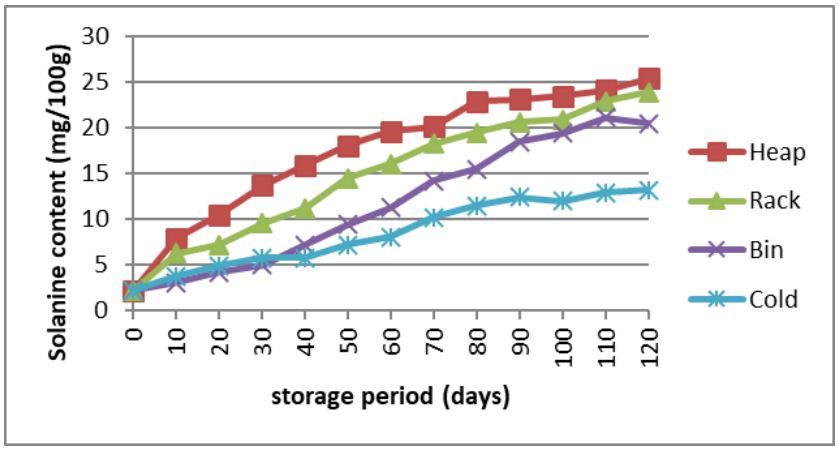

Fig 1: The effect of storage methods on solanine content of Kufri Jyoti variety potato

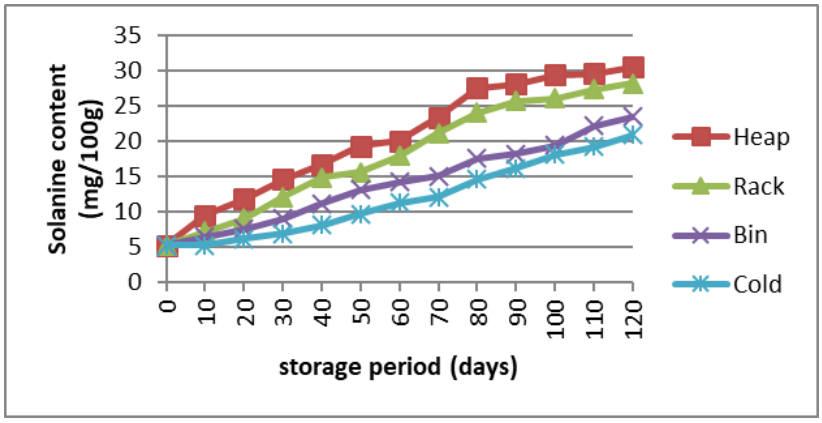

Fig 2: The effect of storage methods on solanine content of Kufri Giriraj variety potato

4. Conclusion

Among the two varieties, Kurfi Giriraj showed higher solanine content than Kufri Jyoti. Solanine content of the tubers was high in heap storage when compared with rack, ventilated bin and cold storage for both varieties. This is due to the exposure of potato tubers to higher temperature and light. In Heap storage, the temperature is 22 °C and exposure of sunlight is also high. Whereas in cold storage, the temperature is 4 °C and low exposure to light that results in low synthesis of solanine content.

5. References

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