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Change in bruise susceptibility of potatoes during storage

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Abstract

The change in bruise susceptibility of potatoes during storage was investigated using a potato chip processing variety, Norin ichigo for about 3 months. The black-spot bruise susceptibility of potatoes was high at harvest, followed by a gradual decrease, but increased after sprouting. A linear relationship between penetration force to potato skin and bruise rating was found ; the significant relation ($p<0.05$) indicated that the penetration force is a predictor of potato bruising.

Key words : Nourin-ichigo potatoes, storage, bruise susceptibility, penetration force

INTRODUCTION

Discoloration of raw potatoes, an abnormal physiological condition which occurs when potatoes are bruised, is one of the most serious and costly problems affeting the potato industry. If the mechanism responsible for this type of discoloration could be clearly defined, perhaps methods of controlling or preventing discoloration might be developed[1)].

Blackspot bruise evaluations are most often conducted at harvest in order to determine how harvesting and handling operations or cultural practices have influenced this disorder. Susceptibility to blackspot at the time when tubers are removed from storage, particularly if the potatoes are for a fresh market, should also be evaluated[2)]. Shippers (1971)[3)] indicated that bruise susceptibility decreased slowly in storage. However, Mondy et al. (1960)[1)] indicated that discoloration as a measure of bruise susceptibility increased with storage duration. The propensity to bruise or discolor following storage has not been clearly defined.

In this study, the change in blackspot bruise susceptibility of potato tubers during storage was investigated for about 3 months.

MATERIALS AND METHODS

Source and tuber storage

Norin-ichigo potatoes were harvested on Sep. 30, 1991. After harvesting, those potatoes (mean weight 140 g) were placed into a commercial storage bin and suberized for 14 days at 15 °C (90%RH). Thereafter, the potatoes were stored at 11 °C for roughly 3 months.

Bruising

Blackspot bruising was produced[4)] by dropping a 100 g weight 70 cm through a cylindrical tube onto the tuber surface at the stem-end "shoulder".

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Assays

Weight loss

Five samples were weighed before and after storage.

Moisture

Five potato tubers were washed, peeled and diced into approximately 5 mm cubes. Moisture of the samples (10g) was determined by predrying at 70°C for 24 hours and drying at 70°C in a vacuum oven for 2 hours[5].

Bruise assessment

The size and gray-black color intensity of the resulting blackspot bruises were rated 48hr after bruising according to the following scale, modified from Schippers (1971)[3]:

0 = no discoloration

1 = very small spots or vaguely defined

2 = diameter 3 to 5 mm, color gray or brownish

3 = diameter 5 to 10 mm, depth less than 5 mm, color gray or black

4 = diameter 5 to 10 mm, depth greater than 5 mm, color gray or black

5 = diameter greater than 10 mm, depth greater than 5 mm, color black

A mean was calculated for 10 tubers.

Penetration force

Following the procedure of Mohsenin (1963)[6], compression tests were conducted on potatoes using a 2 mm diameter loading plunger. Tuber samples were compressed at a rate of 20 cm per minute. Only maximum penetration force was used in this study.

A mean was calculated for 10 tubers.

RESULTS

Figure 1 shows the weight loss of potatoes during storage. As shown in this figure, weight loss increased gradually with storage time. Potatoes sprouted around day 85 of storage, after which weight loss increased rapidly.

Figure 2 shows the moisture content of potatoes during storage. As illustrated in the figure, moisture content remained almost constant over storage duration.

At harvest time, the percent of tubers injured was high, but declined gradually with storage (Fig. 3a). However, it increased after sprouting (around day 85 of storage). Also, the bruise rate followed the same trend as the percent of tubers injured (Fig. 3b).

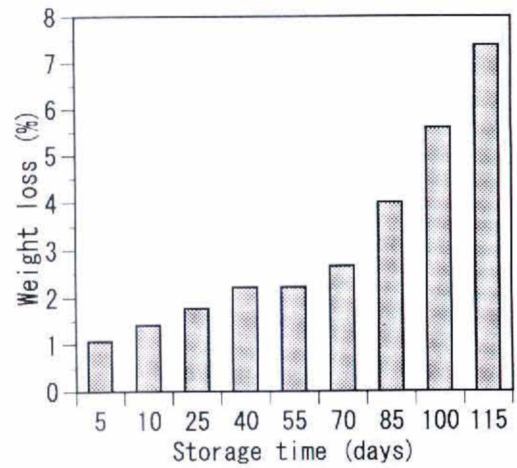

Fig. 1 Weight loss of potatoes during storage at 11°C

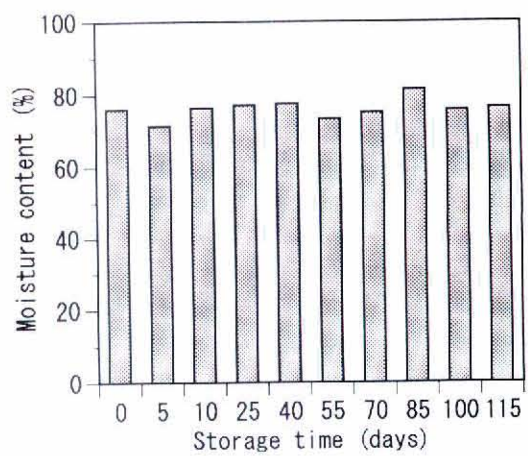

Fig. 2 Moisture content of potatoes during storage at 11°C

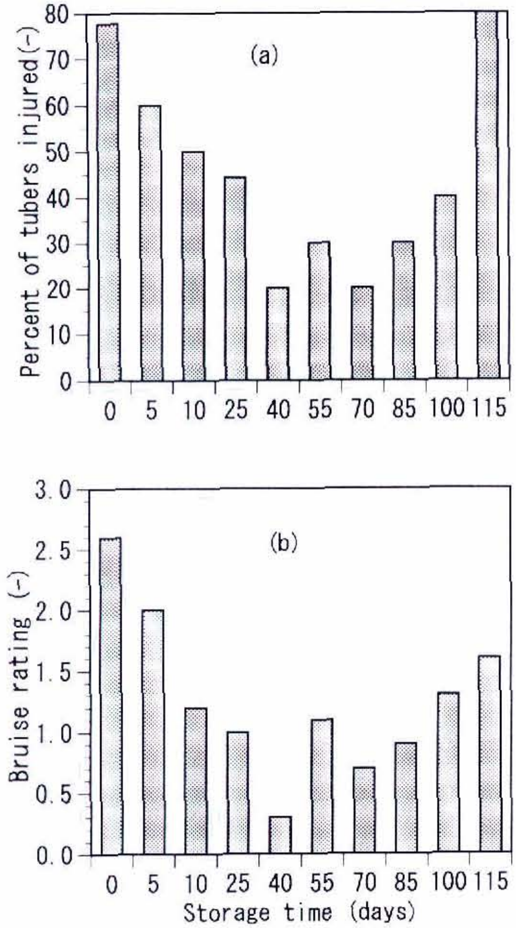

Fig. 3 Bruise susceptibility of potatoes during storage at 11°C
(a) Blackspot probability
(b) Blackspot intensity

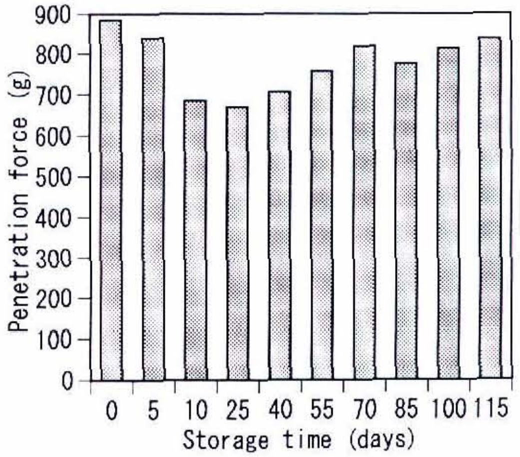

Fig. 4 Change in skin firmness of potatoes during storage at 11°C

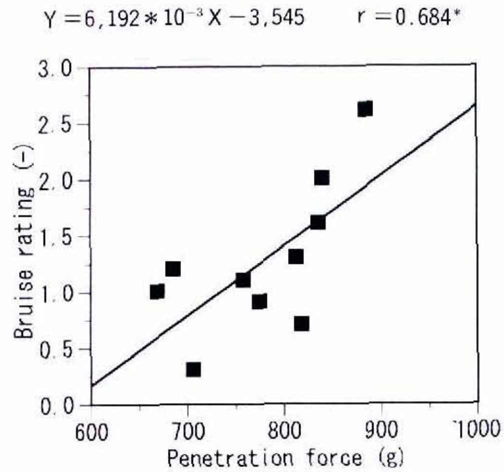

Fig. 5 Relationship between penetration force and bruise susceptibility of potatoes during storage at 11°C

The potato skin was firm at harvest time, but penetration force decreased gradually on further storage (Fig. 4).

Figure 5 shows a significant linear relationship ($p < 0.05$) between penetration force and bruise rating. This suggests that the penetration force could be used as a proper indicator for bruise susceptibility.

DISCUSSION

Tuber firmness, which is influenced by the turgidity and cellular structure of the tuber markedly influences damage within a variety. Generally growing conditions which increase turgidity and cell tension in the tuber increase susceptibility to structural cell wall failure during impact.

Freshly dug tubers are more turgid than stored tubers and are thus more susceptible to cracking and splitting (Hughes, 1980[7]). In our study, freshly dug tubers were more susceptible to bruising than stored tubers (Figs. 3-5).

With regard to tuber size and shape, large tubers are more susceptible to damage than small tubers. Tubers with a small radii of curvature tend to be more susceptible to damage than small tubers. Size and shape are genetically controlled and should be considered in selection for damage resistant varieties (Hughes, 1980[7]).

Several uncontrollable factors influence the development of black spots from bruising. Impact damage during harvesting and handling causes bruising and eventually black spots[8)-11)]. Soil condition[12)], tuber temperature[13)], variety[14)] and fertilization[15)] all play a vital role in the development of black spots in bruised potato tubers.

In addition to the above external factors, the role of biochemical components of tubers is important.

Browning in potato has been correlated with PPO activity and the concentrations of PPO substrates (Matheis and Belitz, 1978[16)]; Brudzynski and Zawidzka-Okoniewska, 1979[17)]; Stark et al., 1985[18)]; Matheis, 1987[19)]). Matheis and Belitz (1978)[16)] concluded that enzymatic browning in potatoes correlates with tyrosine turnover, a parameter which depends on the concentrations of PPO, tyrosine, chlorogenic acid and ascorbic acid, rather than on any single factor.

Blackspot bruising of potato tubers depends on the propensity of the tissue to mechanical injury and its biochemical potential for pigment development[2)]. More study is needed to determine the effect of the physical and biochemical properties of the bruise susceptibility of potatoes.

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貯蔵馬鈴薯の内部損傷の変化

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和 文 摘 要

貯蔵馬鈴薯の内部損傷の変化を３ヶ月間にわたって研究した。農林１号は，収穫時にもっとも損傷を受けやすく，貯蔵中は徐々に減少したが，発芽時に再び上昇した。貯蔵馬鈴薯のプランジャーによる貫入力と内部損傷の損傷程度との間には，有意な直線関係が見られ，貫入力測定は，貯蔵馬鈴薯の内部損傷の損傷程度を予測する有効な手段であった。

キーワード：農林１号，貯蔵，内部損傷，貫入力

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