馬鈴薯の生理, 形態学的研究

第 10 報 馬鈴薯塊莖形成時に於けるアスコルビン酸の生理作用に就いて
(抄 報)

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Physiological and morphological studies on potato plants
 Part 10. On the physiological behavior of ascorbic acid in the formation of potato tubers
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馬鈴薯塊莖のアスコルビン酸含量は成熟に伴い増加するものであるが、他方アスコルビン酸はアミラーゼ作用に阻害的影響を及ぼす事が知られている。本実験は馬鈴薯「男爵薯」を用い、塊莖形成の過程に於けるアスコルビン酸含量の変化と、諸炭水化物の消長に就いての、相互関係を明かにする目的で行つたものである。

実験結果並に考察

匍枝発生よりその先端が肥大するまでは、還元糖と総アスコルビン酸の増加が見られる。而してアスコルビン酸は酸化型の増加が著明で、従つて還元型対酸化型の比率は生育に伴い減少を來した。

匍枝先端の肥大開始に伴い、総アスコルビン酸は次第に増加を示したが、之に伴つて還元糖の減退並に澱粉の増加が見られた。而してアスコルビン酸は還元型の増加と酸化型の減少に依り、両者の比率の増加も顕著にみられた。

塊莖の成熟期に於いては、塊莖内の澱粉蓄積の増加と共に、アスコルビン酸の増加率は低下した。

以上の実験結果を要約すると、匍枝伸長期に於いては、還元糖に富み、酸化型アスコルビン酸の増加が認められた。匍枝先端部の膨大に伴つてアスコルビン酸の増加、還元糖の減少、澱粉の増加が認められた。更に塊莖の成熟と共に澱粉の増加に相応じてアスコルビン酸含量、特にその還元型含量の増加、アミラーゼ糖化力の減退がみられたが、是等の事実からアスコルビン酸が澱粉の蓄積に対し間接的に何らかの関係を有する事が予想される。

Figure 1. The variations of total ascorbic acid, reducing sugar and starch contents in the tips of potato stolon and tubers.

Résumé

This investigation is one of a series of experiments carried out under the title of physiological studies on potato plants. It has long been known that potato tubers are an important source for the supply of ascorbic acid (Vitamin C) as a dietary essential for human nutrition. Although a great number of studies on the ascorbic acid contents in potato tubers

* 昭和 27 年 2 月 23 日 第 94 回講演会に於て発表
 日本作物学会紀事 第 21 卷 第 3~4 号

Figure 2. Variations of the reduced form, oxidized form and the reduced form/oxidized form of ascorbic acid in the tips of potato stolon and tubers.

have recently been reported by many investigators, few data concerning the influence of ascorbic acid on the tuberization and maturity of the potato tubers, especially on the accumulation of starch in the new tubers, are available. In the present investigation, in extending the work on the carbohydrate metabolism of potato tubers, particular attention was given to a study on the physiological interrelationship between the accumulation of starch and the variation of ascorbic acid content in the potato tuber during the time of its development. The analysis was carried out on the following fractions, namely, total ascorbic acid, reduced ascorbic acid, oxidized ascorbic acid, reducing sugar, non-reducing sugar, and starch during the period from late May to the beginning of August. The experimental results obtained may be summarized as follows:

(1) The ascorbic acid metabolism during the stolon elongation stage.

The stolon arises in the axils of underground main stem soon after the germination. The total ascorbic acid and the reducing sugar contents in the stolon increase with the development of the stolon. At this stage, however, the amount of ascorbic acid, especially in the reduced form, in the stolon tips was less than that of the following stage; the decline of the ratio of reduced form/oxidized form of ascorbic acid may be pointed out as a characteristic feature at this stage.

(2) The ascorbic acid metabolism during the tuberization stage.

The duration of this stage is very short, from the middle of June to late in June. The tips of the stolons began to swell into a spindle shape as soon as the elongation ceased and then gradually became tuberous through the deposition of starch in them. As a characteristic feature at this stage a conspicuous increase of ascorbic acid content and a decrease of reducing sugar content in the stolon tips were recognized. When reviewing the works of PURR (1934), HANES (1935) and NISHIDA (1951) which state that the ascorbic acid is very effective for inhibiting amylase activity, it is very interesting to assume that the ascorbic acid in the potato tubers may act as an activator in the formation of starch in the stolon tips. In the previous paper, the authors have reported the fact that the amylase activity declined rapidly with the development of new tuber. This experimental evidence reported by the author added confirmatory support to the previous assumption of inhibitory effect of the ascorbic acid upon the amylase activity. At any rate, a close relationship between the accumulation of starch and the increase of the ascorbic acid content in the new tubers is supposed to exist.

(3) The ascorbic acid metabolism during the tuber maturing stage.

When the tubers attained maturity the leaves gradually died, and the onset of ripening of the new tubers roughly coincided with the yellowing and drying up of the vines. With the increasing maturity of the tuber the rate of increase of the ascorbic acid content in the new tuber slackened gradually. With respect to the detailed ratio of the constituents of ascorbic acid, an increase of the reduced form and a decrease of the oxidized form were recognized. Accordingly the ratio of reduced form/oxidized form of ascorbic acid also rose. Concomitant with these changes of the ascorbic acid content according to the tuber maturity, the starch content in the new tuber increased steeply.