

# 沖縄産農産物の物理的処理による 機能性強化



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食品保蔵学会技術賞  
(2007年)



農業機械学会  
北海道支部賞(2004年)



# 真空含侵 (ビタミンC)



## Ascorbic acid enrichment of whole potato tuber by vacuum-impregnation

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### ABSTRACT

The aim of this study was to evaluate the use of vacuum-impregnation (VI) for enriching the ascorbic acid content of whole potatoes. Whole potatoes were immersed in a 10% ascorbic acid (AA) solution. A vacuum pressure of 70 cm Hg was applied for 0–60 min, following atmospheric pressure restoration for 3 h, while samples remained in the VI solution. AA concentrations of potatoes were measured using HPLC. The effects of cooking and storage time in subsets of the fortified samples were also evaluated. Results indicated that the AA concentration of whole potatoes increased with vacuum time (max 150 mg/100 g fr. wt.). In addition, a steam-cooking study showed that 100 g of the 25 min steam-cooked VI potatoes could provide adults with 90–100% of the recommended daily allowance of AA (100 mg). The storage study showed that VI whole potatoes had a relatively high AA concentration (50 mg/100 g fr. wt.), even at 14 days of storage at 4 °C. This study indicated that VI treatment of whole potatoes was useful for enriching the AA content.

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### 1. Introduction

Increased consumer interests in the health benefits of foods have led to significant development of nutraceuticals and functional foods (Zhao & Xieb, 2004). The global functional food market is estimated to be 47.6 billion US\$, the United States being the largest market segment, followed by Europe and Japan (Sloan, 2002). Lastly, the range of functional foods that have potential health benefits has grown tremendously. Examples include baby foods, bakery goods and cereals, confectionery, dairy foods, ready meals, snacks, soft drinks, such as energy and sport drinks, meat products and spreads. These functional foods are associated with various types of benefit, and involve vitamin and mineral fortification, cholesterol reduction, antioxidants, phytochemicals, dietary fibre, herbs and botanicals, and probiotics, prebiotics and symbiotics (Alzamora et al., 2005).

Potato (*Solanum tuberosum* L.) is one of the world's most important crops, ranking fifth in terms of human consumption and fourth in worldwide production (Burgos, Auqui, Amoros, Salas, & Bonierbale, 2009). Beyond supplying energy and good quality protein, potato is also an important source of vitamins and minerals. However, its value within the human diet – particularly as a source of vitamin C – is often underestimated or ignored (Dale, Griffiths, & Todd, 2003). Potatoes have relatively high ascorbic acid (AA) contents. AA is an essential component of most living tissues. The

metabolic role of AA is related to an oxidation and reduction reaction in which AA is reversibly oxidised to dehydroascorbic acid. AA promotes the hydroxylation reaction in a number of biosynthetic pathways (Barnes & Kodeck, 1972; Levine, 1986). Hydroxylation is required to stabilise the triple helical conformation of collagen. Compromised collagen production, associated with AA deficiency, results in impaired wound healing (Bird, Schwartz, & Peterkofsky, 1986). Moreover, AA plays an important role in protection against oxidative stress as an antioxidant. AA is an important scavenger of free radical species, such as reactive oxygen species that can cause tissue damage resulting from lipid peroxidation, DNA breakage or base alterations, and may contribute to degenerative diseases, such as heart disease or cancer (Bates, 1997). Due to its participation in the oxidation of transition metal ions, AA also plays an important role in enhancing the bioavailability of non-haem iron (Teucher, Olivares, & Cori, 2004). The Food and Agriculture Organization (FAO) indicated that the recommended nutrient intake of vitamin C ranges from 25 to 45 mg/day, depending on age. However, based on available biochemical, clinical and epidemiological studies, the current recommended daily allowance (RDA) for AA is suggested to be 100 mg/day for adults to achieve cellular saturation and reduce risk of heart disease, stroke and cancer, in healthy individuals (Naidu, 2003).

Vacuum-impregnation (VI) treatment is effective in preventing discoloration of fruit pieces by enzymatic and oxidative browning, without using antioxidants, via removal of oxygen from the pores (Alzamora et al., 2000; Barbosa-Canovas & Vega-Mercado, 1996). Another important factor contributing to quality improvement is

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E-mail address: [kazuhiro@obihiro.ac.jp](mailto:kazuhiro@obihiro.ac.jp) (K. Hironaka).

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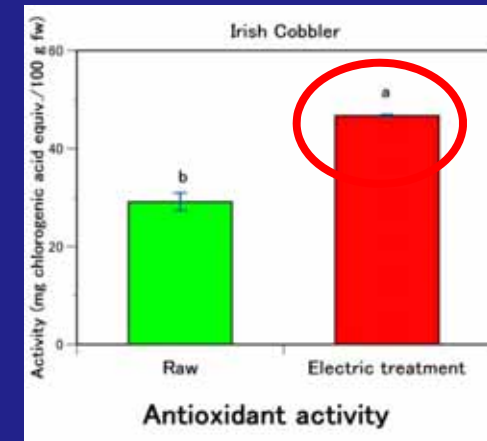
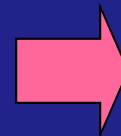
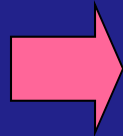
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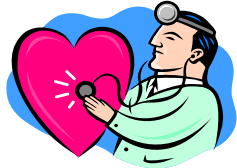
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抗酸化性食品



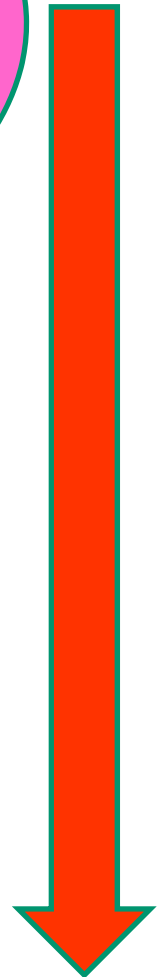
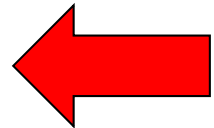
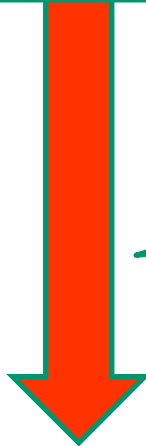
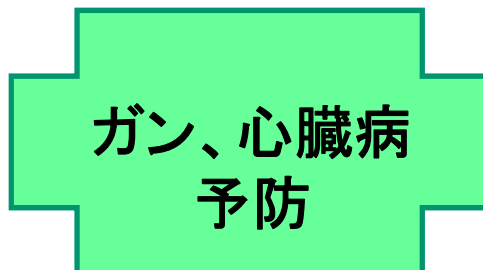
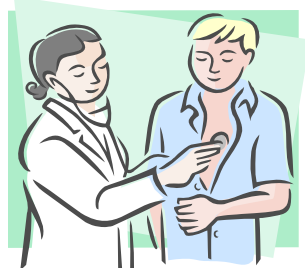
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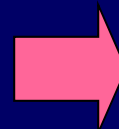
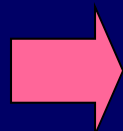


健康生活

ジャガイモで強化



# 真空含浸法による ジャガイモのアスコルビン酸の増強



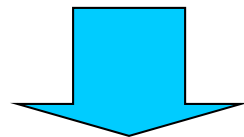
# 背景

北海道は全国のジャガイモ生産量(約300万t)の約80%を占める。

ジャガイモは、



- ・ アスコルビン酸(ビタミンC)が豊富。
- ・ 一度に多量に食べられる。
- ・ 貯蔵できる。

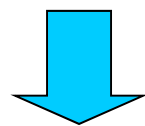


**アスコルビン酸の良い供給源**

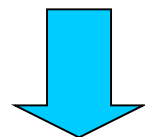


そこで、

アスコルビン酸を**増強した**ジャガイモを作る。



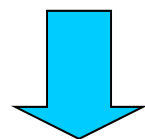
アスコルビン酸溶液に**浸漬**



しかし、

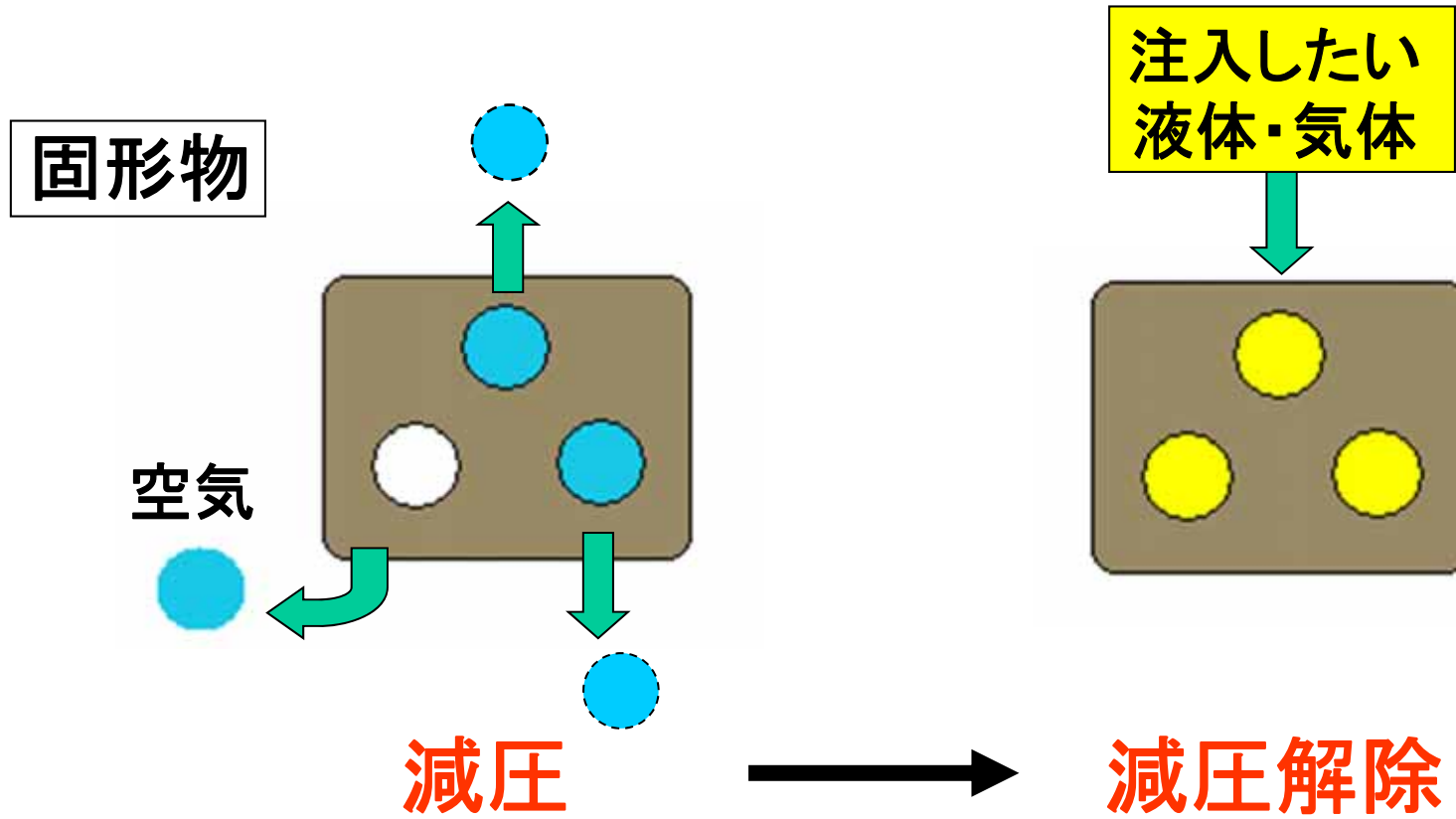
**厚いコルク層の表皮**

浸漬だけでは  
入りづらい？



**真空含浸法**を利用

# 真空含浸法とは



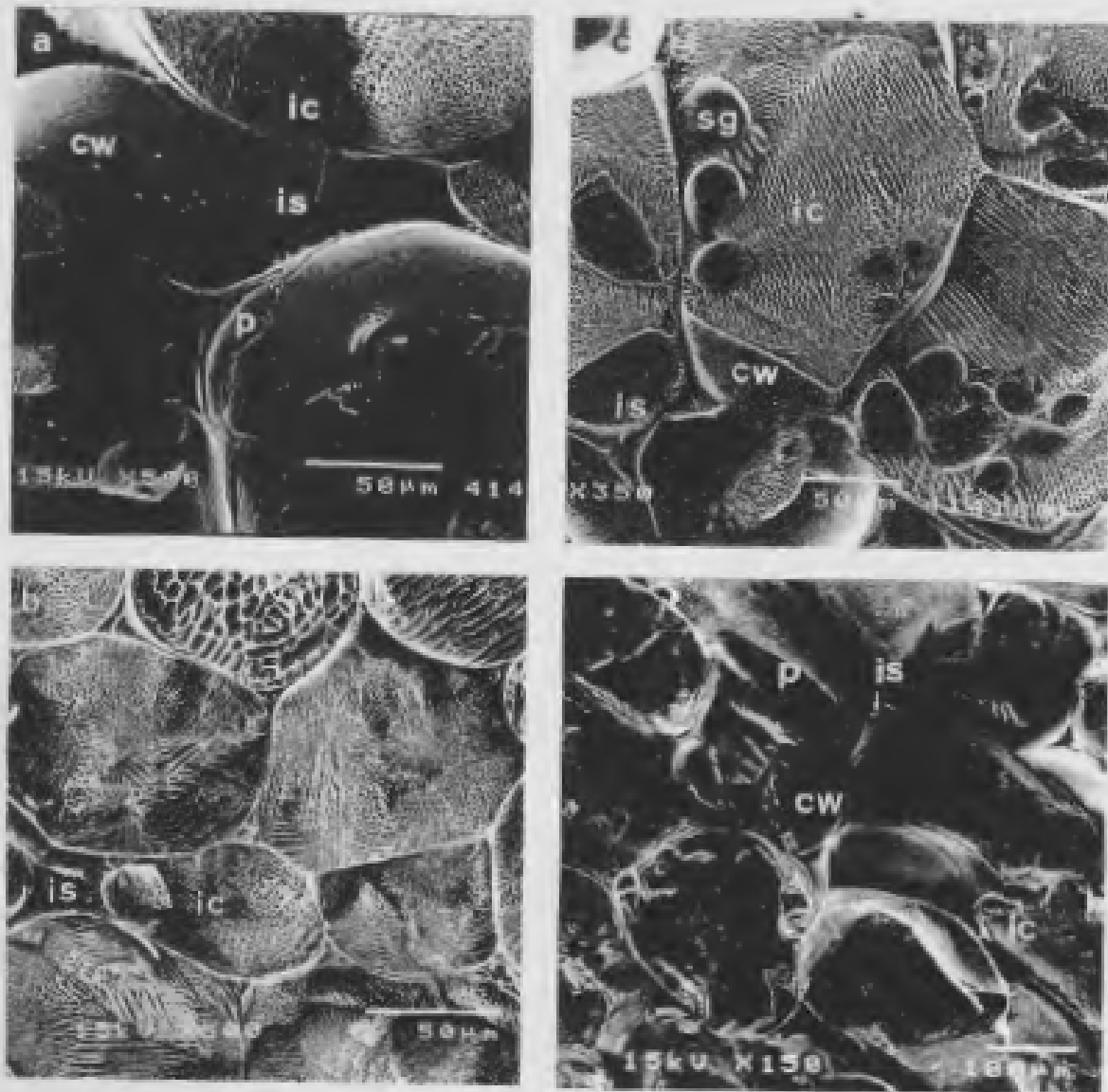
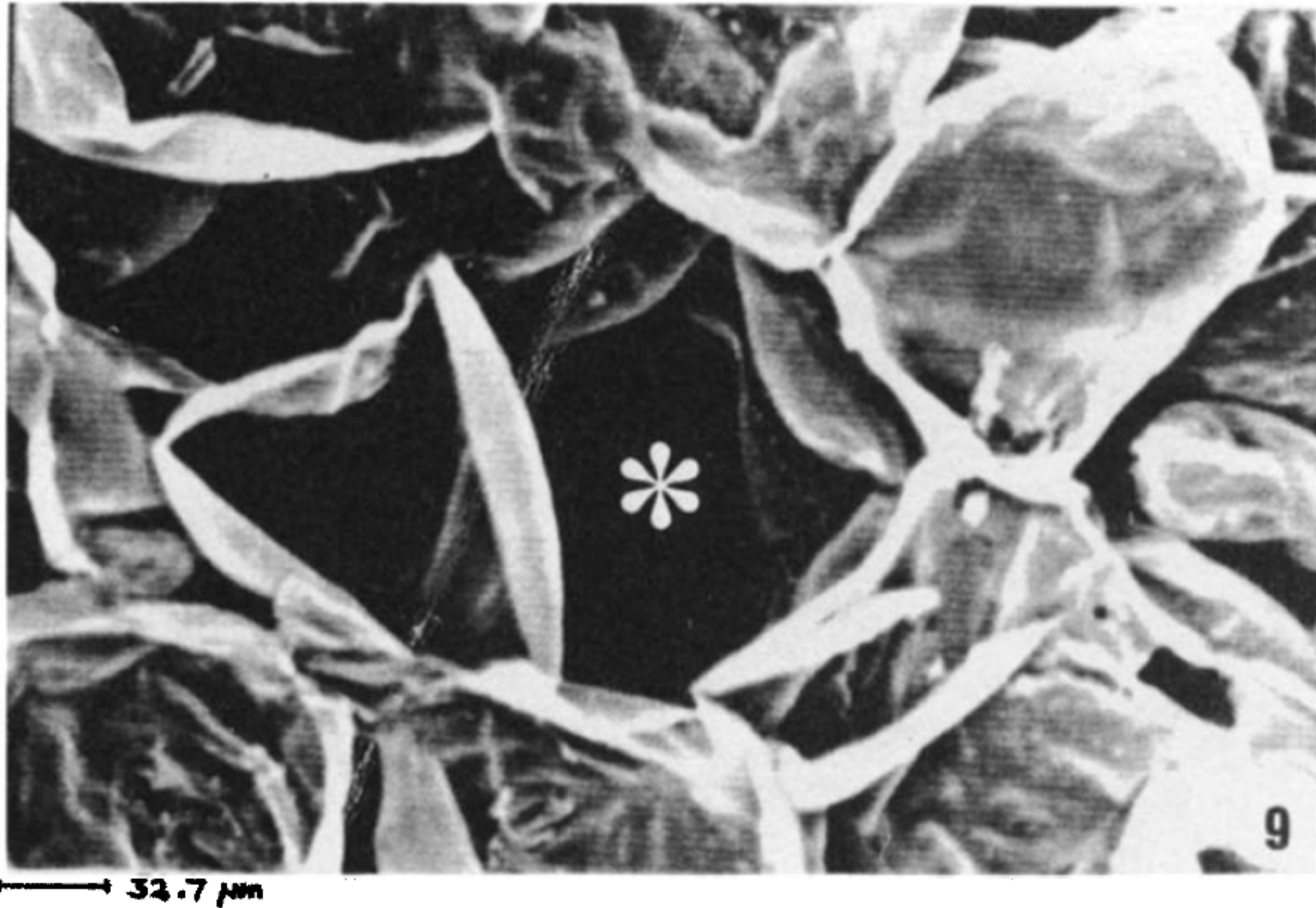


Figure 11-3 CryoSEM micrographs of parenchyma of some vegetal tissues. a: Apple. b: Pineapple. c: Potato. d: Strawberry, showing intercellular spaces with different sizes, with and without native liquid phase. is: intercellular spaces, cw; cell wall, p; plasmalemma, ic; intracellular content, sg; starch granules.



**Fig. 5.** Scanning electron micrograph of apple tissue where an ICS may be observed.

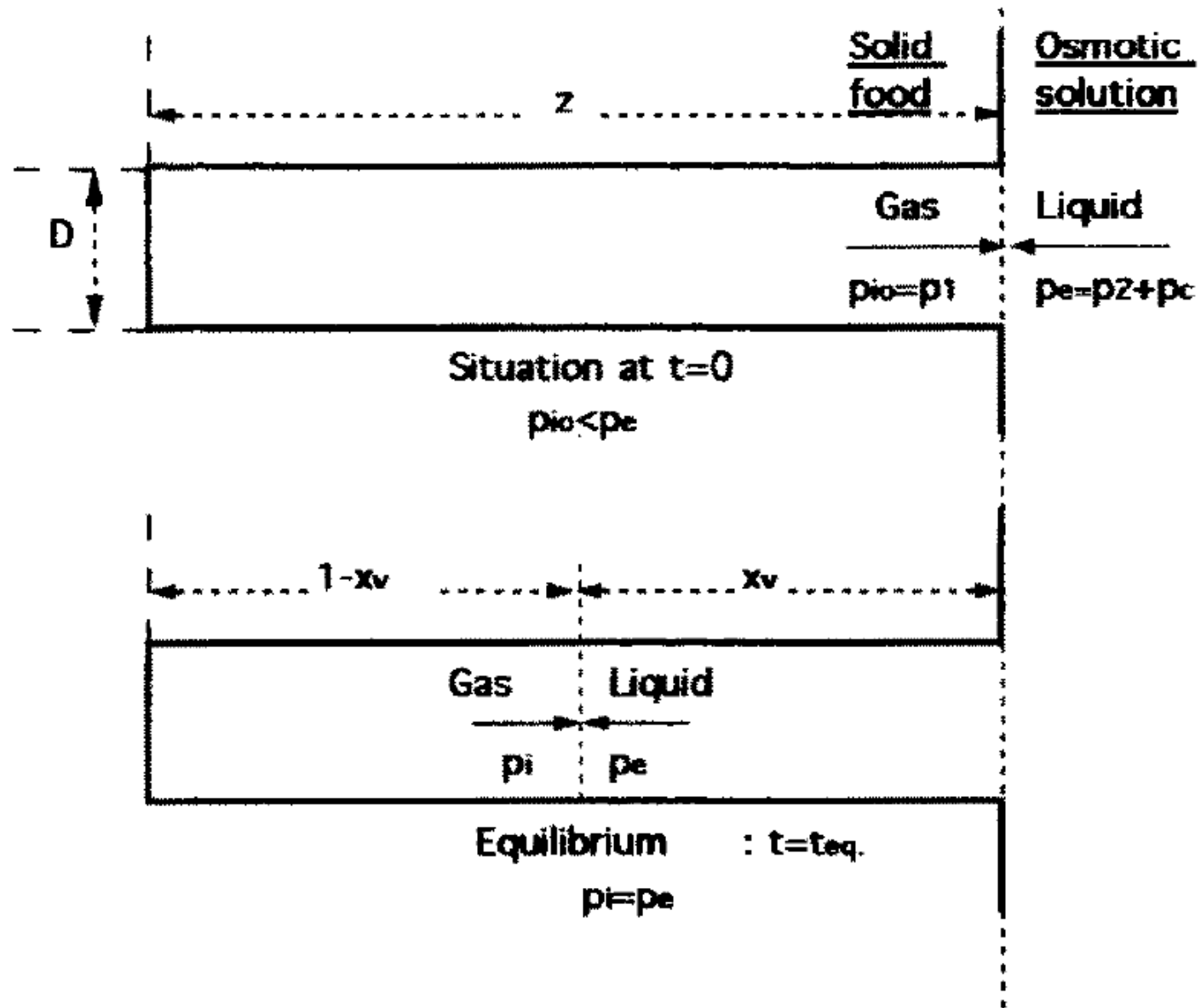
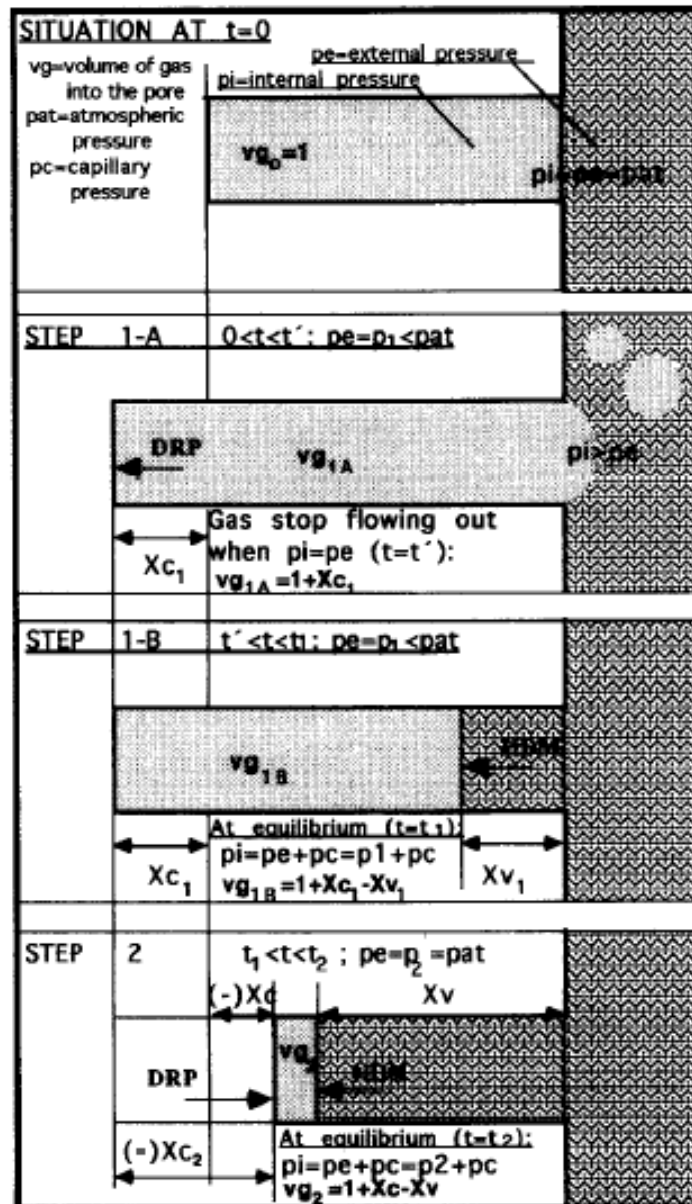


Fig. 6. The HDM in an ideal pore.





DRP = Deformation-Relaxation Phenomena  
HDM = Hydrodynamic Mechanism

Fig. 1. Solid food-liquid system, deformation-relaxation and HDM pathway in an ideal pore.

# 目的

ジャガイモのアスコルビン酸の増強に、  
真空含浸法を用いる。

# 検討事項

1. 浸透の可否

2. 減圧時間

3. 加熱時間

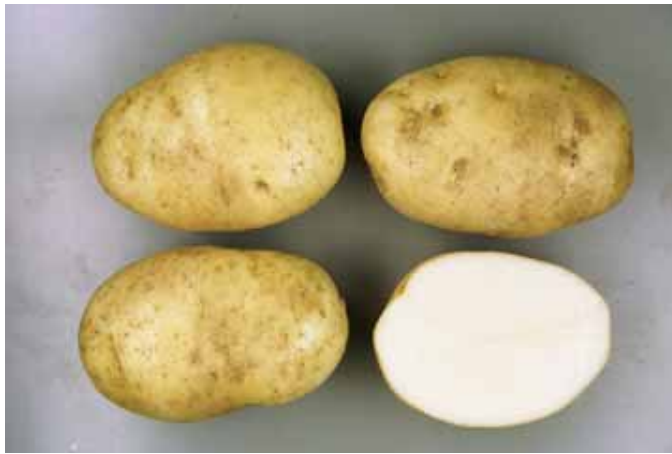
4. 貯蔵期間

# 実験方法



# 供試材料

[品種]



トヨシロ



男爵イモ

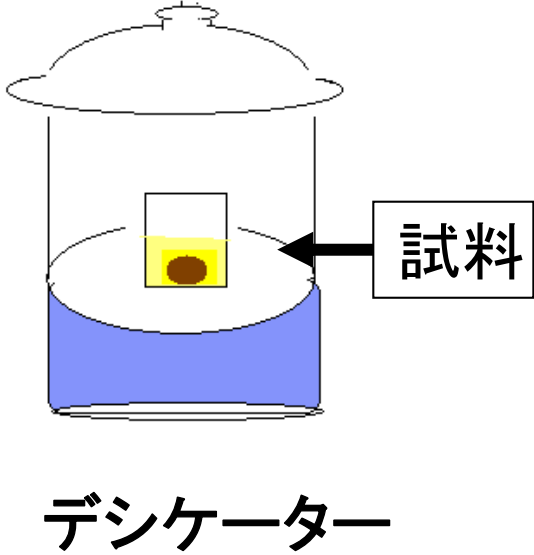
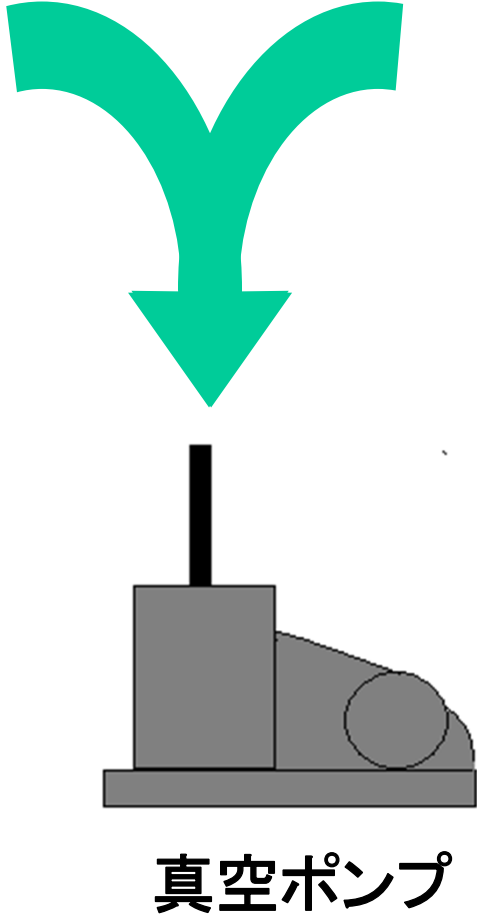
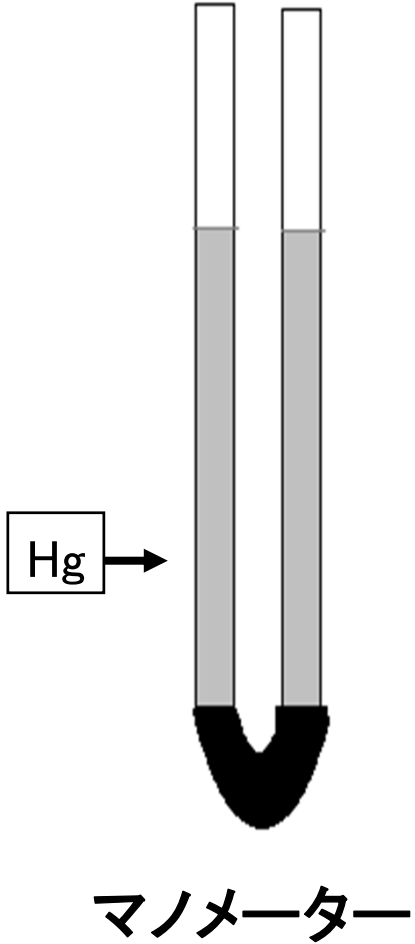
収穫日：2007年9月下旬

搬入日：2007年10月15日(4°Cで貯蔵)

# 真空装置

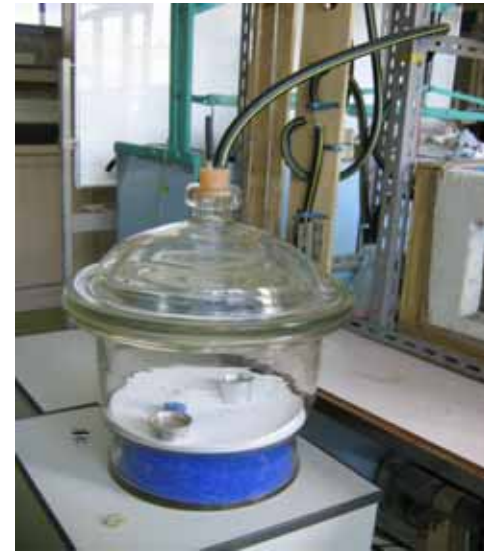
強さ: 70cmHg

減圧





マノメーター



デシケーター

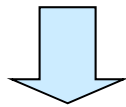


真空ポンプ

# ジャガイモのアスコルビン酸強化

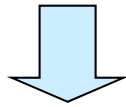
①

準備



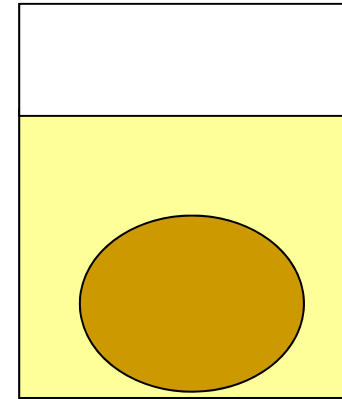
②

真空装置へ



③

20°Cで3時間浸漬



10%アスコルビン酸  
+  
馬鈴薯

\* **未処理**: 減圧・浸漬処理をどちらも行わなかった。

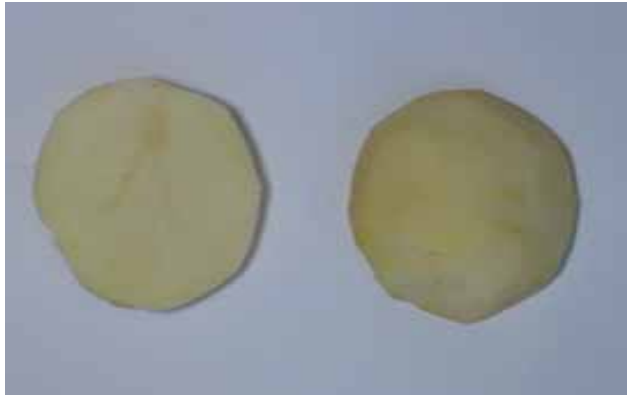
# 結果



# 1. 浸透の可否

# 赤インク溶液に浸漬

3時間浸漬のみ



24時間浸漬のみ



内部に浸透しない。

浸漬のみでは，浸透しない。

# 赤インク溶液に浸漬

1時間減圧直後

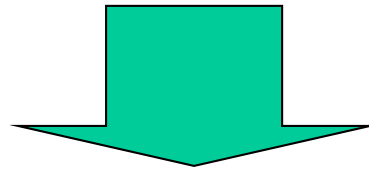


内部に浸透しない。

1時間減圧+3時間浸漬



内部まで浸透。



減圧後，浸漬が必要

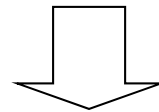
# 赤インク溶液に浸漬



1時間減圧＋3時間浸漬



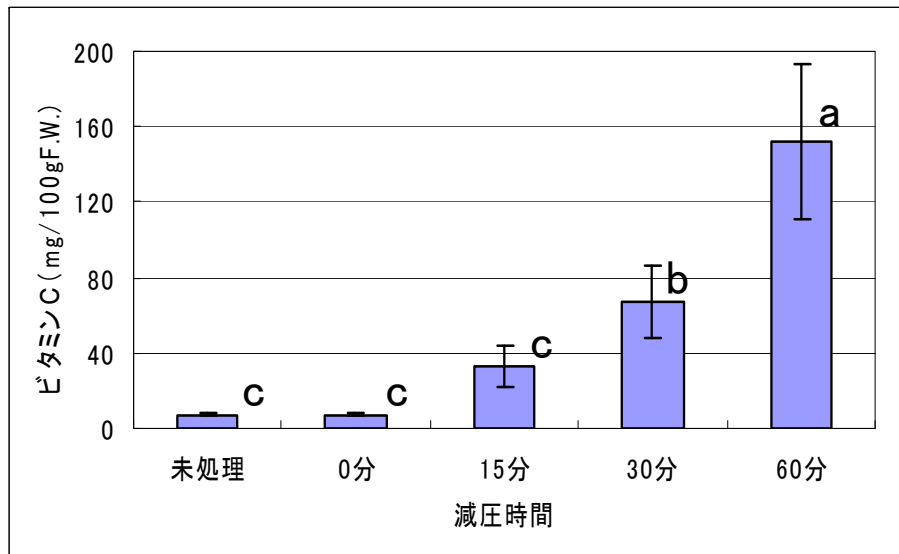
4時間浸漬



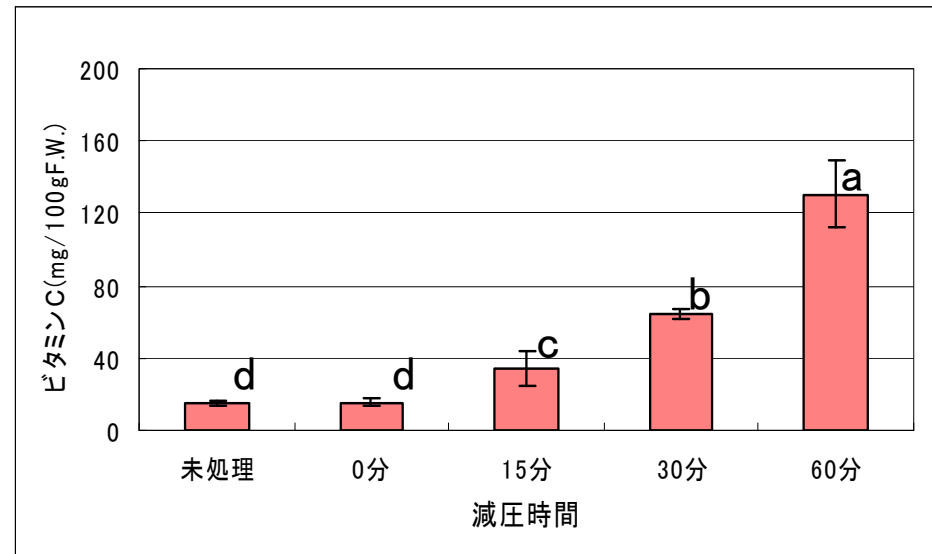
減圧時間: 0, 15, 30, 60分

## 2.減圧時間

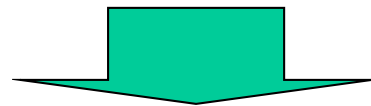
## 減圧時間の違いによるアスコルビン酸含量



トヨシロ



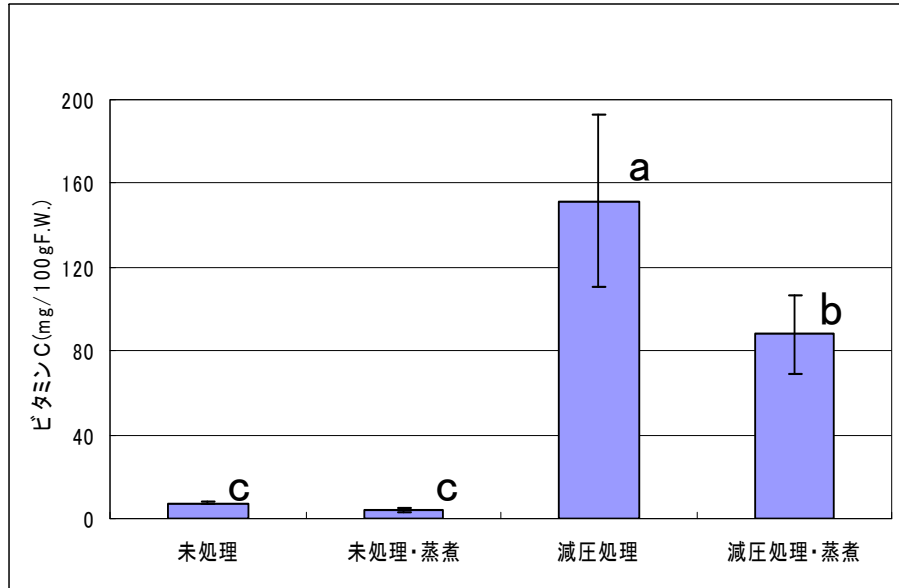
男爵イモ



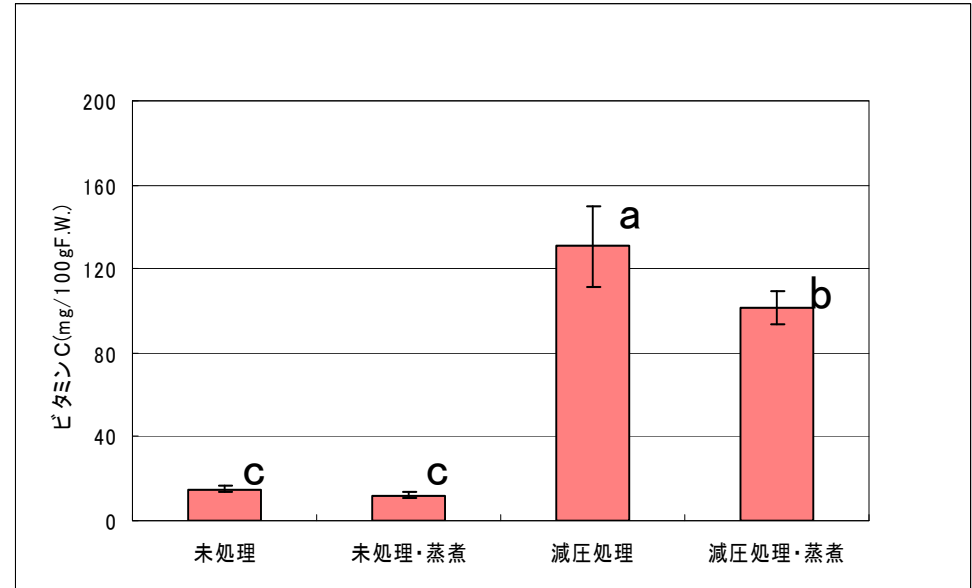
- 浸漬のみでは、アスコルビン酸含量は増加しなかった。
- 減圧時間の増加に従って、アスコルビン酸含量も増加。

# 3.加熱時間

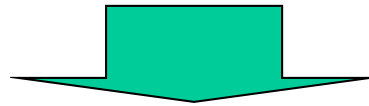
# 加熱(蒸煮)(25分間)の影響(減圧時間60分)



トヨシロ



男爵イモ

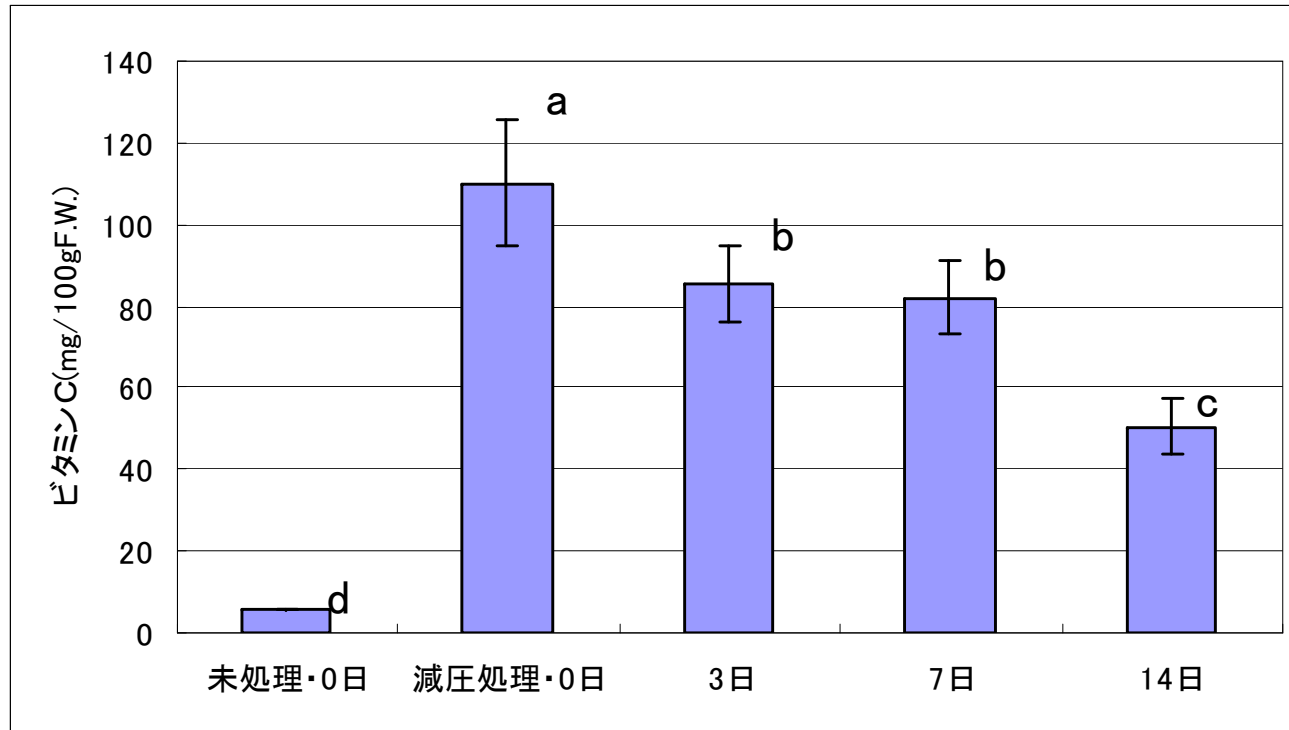


- 加熱しても高いアスコルビン酸含量を保った。

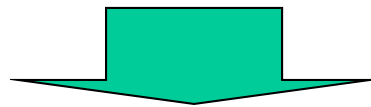


## 4.貯蔵期間

### (3) 貯蔵(4)の影響



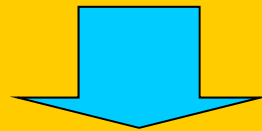
トヨシロ



- ・ 7日目まで、高いアスコルビン酸含量を保った。

# 結 論

- 浸漬のみでは、アスコルビン酸含量は増加しなかった。
- 減圧時間が増加するに従って、アスコルビン酸含量は増加した。
- 加熱してもアスコルビン酸は高い値を保持した。
- 7日程度の貯蔵では、アスコルビン酸は高い値を保持した。



真空含浸法は、ジャガイモのビタミンCを強化するのに有効な方法であると考ええる。



## Ascorbic acid enrichment of whole potato tuber by vacuum-impregnation

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Ascorbic acid  
Steam-cooking  
Storage

### ABSTRACT

The aim of this study was to evaluate the use of vacuum-impregnation (VI) for enriching the ascorbic acid content of whole potatoes. Whole potatoes were immersed in a 10% ascorbic acid (AA) solution. A vacuum pressure of 70 cm Hg was applied for 0–60 min, following atmospheric pressure restoration for 3 h, while samples remained in the VI solution. AA concentrations of potatoes were measured using HPLC. The effects of cooking and storage time in subsets of the fortified samples were also evaluated. Results indicated that the AA concentration of whole potatoes increased with vacuum time (max 150 mg/100 g fr. wt.). In addition, a steam-cooking study showed that 100 g of the 25 min steam-cooked VI potatoes could provide adults with 90–100% of the recommended daily allowance of AA (100 mg). The storage study showed that VI whole potatoes had a relatively high AA concentration (50 mg/100 g fr. wt.), even at 14 days of storage at 4 °C. This study indicated that VI treatment of whole potatoes was useful for enriching the AA content.

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### 1. Introduction

Increased consumer interests in the health benefits of foods have led to significant development of nutraceuticals and functional foods (Zhao & Xieb, 2004). The global functional food market is estimated to be 47.6 billion US\$, the United States being the largest market segment, followed by Europe and Japan (Sloan, 2002). Lastly, the range of functional foods that have potential health benefits has grown tremendously. Examples include baby foods, bakery goods and cereals, confectionery, dairy foods, ready meals, snacks, soft drinks, such as energy and sport drinks, meat products and spreads. These functional foods are associated with various types of benefit, and involve vitamin and mineral fortification, cholesterol reduction, antioxidants, phytochemicals, dietary fibre, herbs and botanicals, and probiotics, prebiotics and symbiotics (Alzamora et al., 2005).

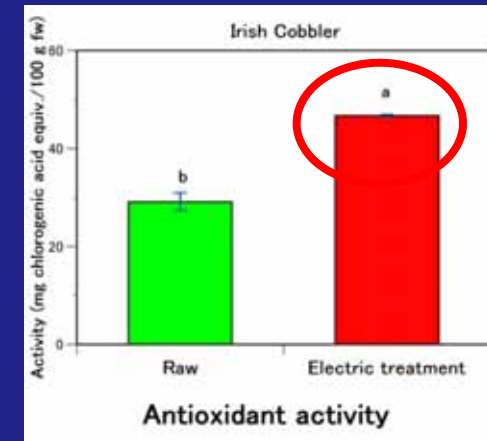
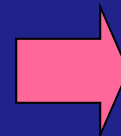
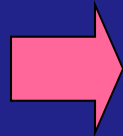
Potato (*Solanum tuberosum* L.) is one of the world's most important crops, ranking fifth in terms of human consumption and fourth in worldwide production (Burgos, Auqui, Amoros, Salas, & Bonierbale, 2009). Beyond supplying energy and good quality protein, potato is also an important source of vitamins and minerals. However, its value within the human diet – particularly as a source of vitamin C – is often underestimated or ignored (Dale, Griffiths, & Todd, 2003). Potatoes have relatively high ascorbic acid (AA) contents. AA is an essential component of most living tissues. The

metabolic role of AA is related to an oxidation and reduction reaction in which AA is reversibly oxidised to dehydroascorbic acid. AA promotes the hydroxylation reaction in a number of biosynthetic pathways (Barnes & Kodeck, 1972; Levine, 1986). Hydroxylation is required to stabilise the triple helical conformation of collagen. Compromised collagen production, associated with AA deficiency, results in impaired wound healing (Bird, Schwartz, & Peterkofsky, 1986). Moreover, AA plays an important role in protection against oxidative stress as an antioxidant. AA is an important scavenger of free radical species, such as reactive oxygen species that can cause tissue damage resulting from lipid peroxidation, DNA breakage or base alterations, and may contribute to degenerative diseases, such as heart disease or cancer (Bates, 1997). Due to its participation in the oxidation of transition metal ions, AA also plays an important role in enhancing the bioavailability of non-haem iron (Teucher, Olivares, & Cori, 2004). The Food and Agriculture Organization (FAO) indicated that the recommended nutrient intake of vitamin C ranges from 25 to 45 mg/day, depending on age. However, based on available biochemical, clinical and epidemiological studies, the current recommended daily allowance (RDA) for AA is suggested to be 100 mg/day for adults to achieve cellular saturation and reduce risk of heart disease, stroke and cancer, in healthy individuals (Naidu, 2003).

Vacuum-impregnation (VI) treatment is effective in preventing discoloration of fruit pieces by enzymatic and oxidative browning, without using antioxidants, via removal of oxygen from the pores (Alzamora et al., 2000; Barbosa-Canovas & Vega-Mercado, 1996). Another important factor contributing to quality improvement is

\* Corresponding author. Tel.: +81 155 49 5572; fax: +81 155 49 5577.  
E-mail address: [kazuhiro@obihiro.ac.jp](mailto:kazuhiro@obihiro.ac.jp) (K. Hironaka).

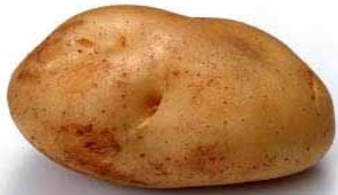
# 電気処理によるジャガイモの品質向上







背景



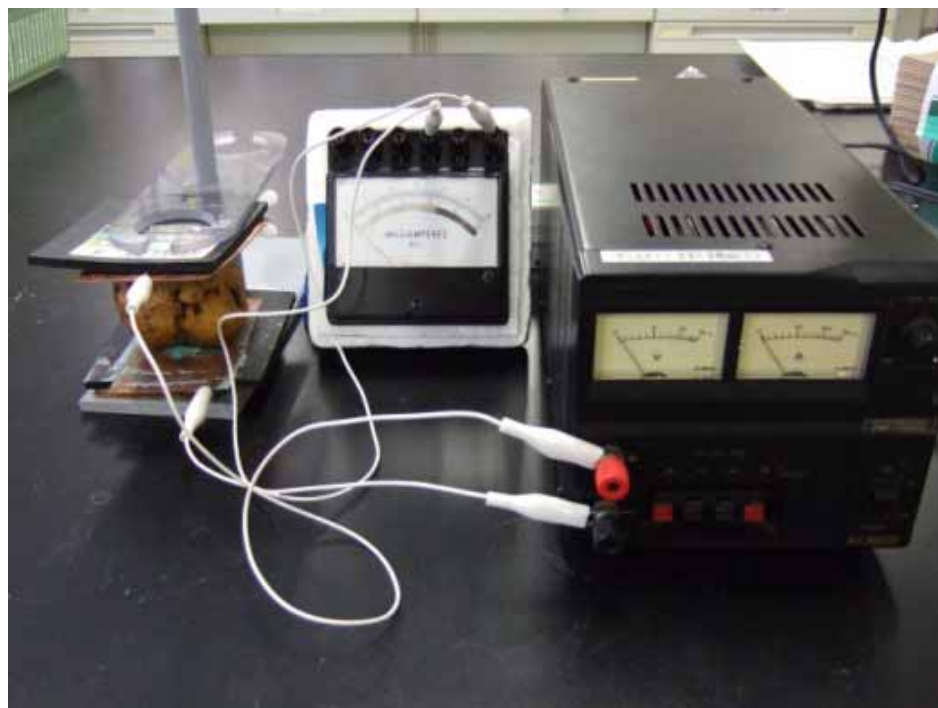
- 北海道の特産物
  - 加工性に富む
- 食事として摂取する機会が多い
  - 一度に多く摂取できる
  - 貯蔵期間が長い



馬鈴薯の栄養価を高めれば、  
栄養素を取り込むのに優良な供給源になりうる



# 電気処理とは？



15V, 4.5mA



目的

ジャガイモの抗酸化活性増強に  
電気処理を行う。

# 検討事項

1.通電時間

2.処理後放置時間



# 実験方法



# 1. 供試材料

男爵イモ



食用

スノーデン



加工用

収穫日：2009年9月下旬

## 2.電気処理

ジャガイモ

3%食塩液  
+  
馬鈴薯

10秒間浸漬

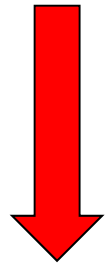


電気処理





**1) 通電時間**  
**(0, 10, 20, 30分)**



**2) 処理後放置時間**  
**0, 12, 24時間**





結 果



Fig. 1 Effect of electric treatment on chlorogenic acid content of potatoes (Irish Cobbler)

E30は、クロロゲン酸を1.3倍増加させた。

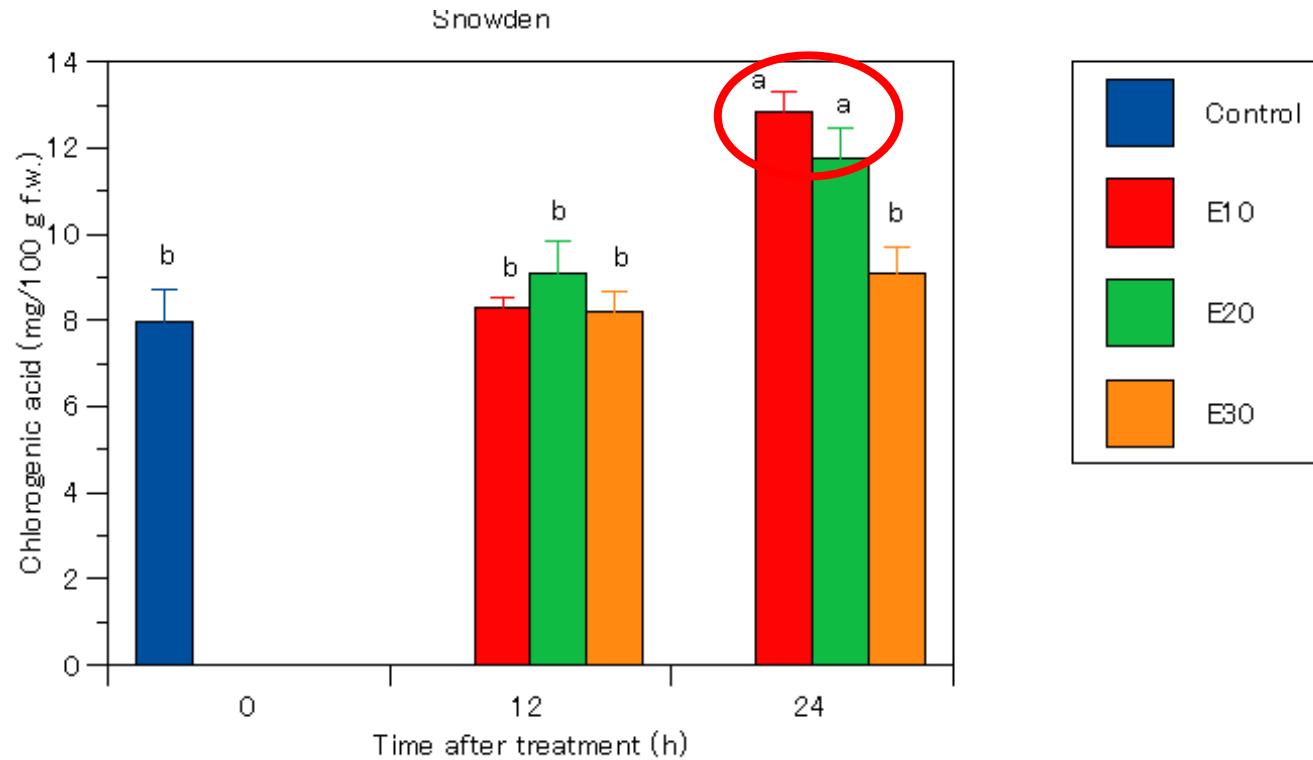


Fig. 2 Effect of electric treatment on chlorogenic acid content of potatoes (Snowden)

**E10, E20は24時間後, クロロゲン酸を1.6倍増加させた。**

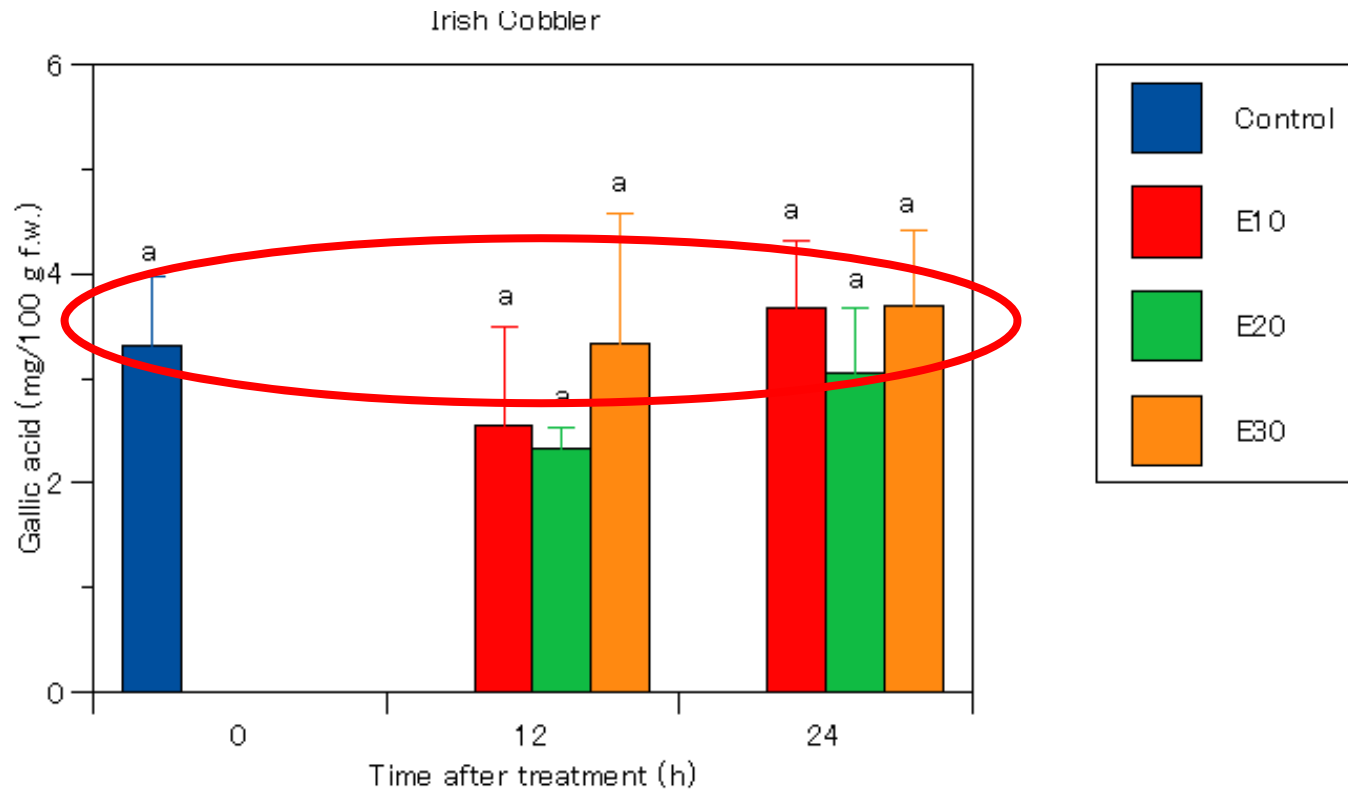


Fig. 3 Effect of electric treatment on gallic acid content of potatoes (Irish Cobbler)

没食子酸は変化なし。

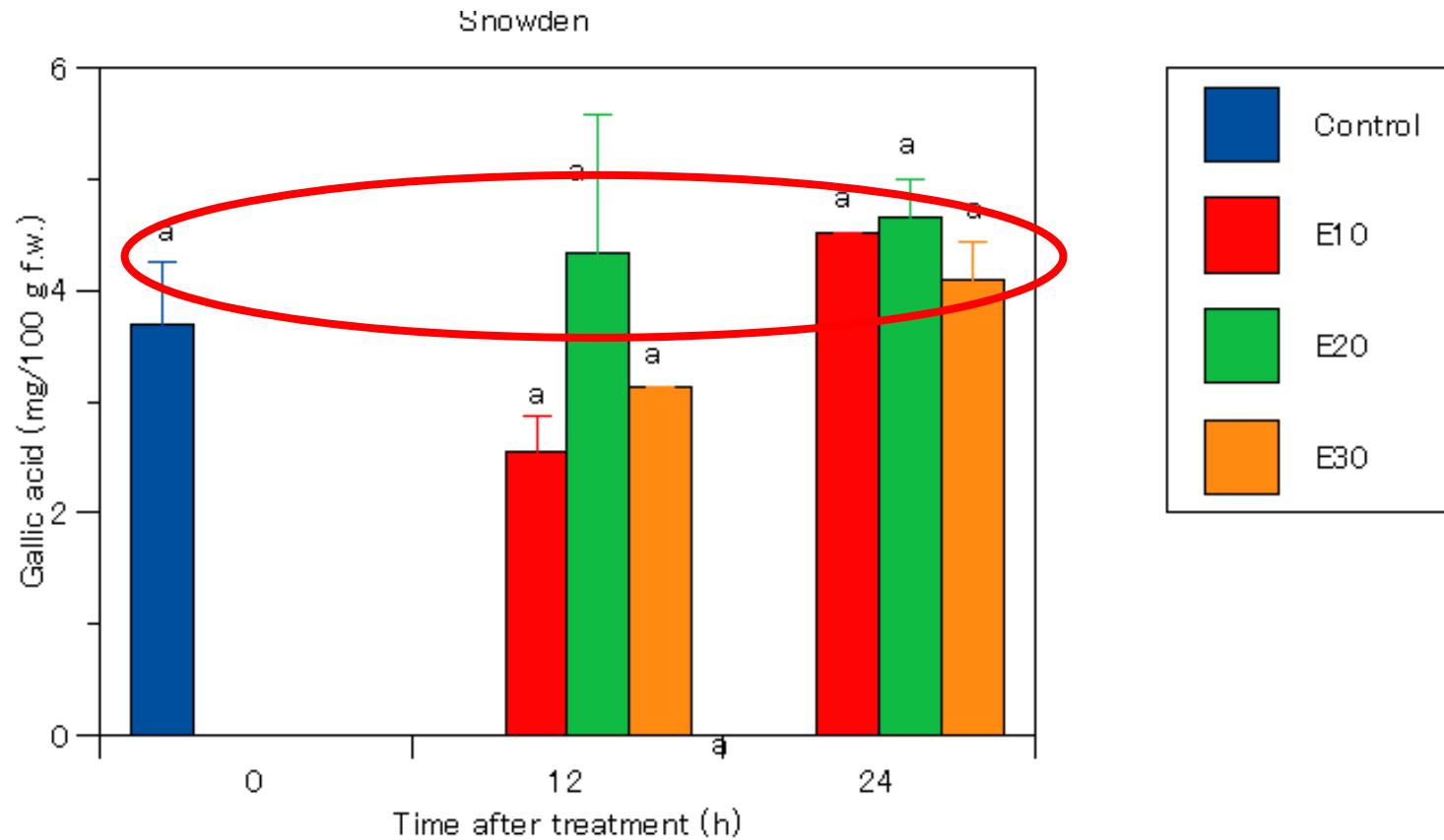


Fig. 4 Effect of electric treatment on gallic acid content of potatoes (Snowden)

没食子酸は変化なし。

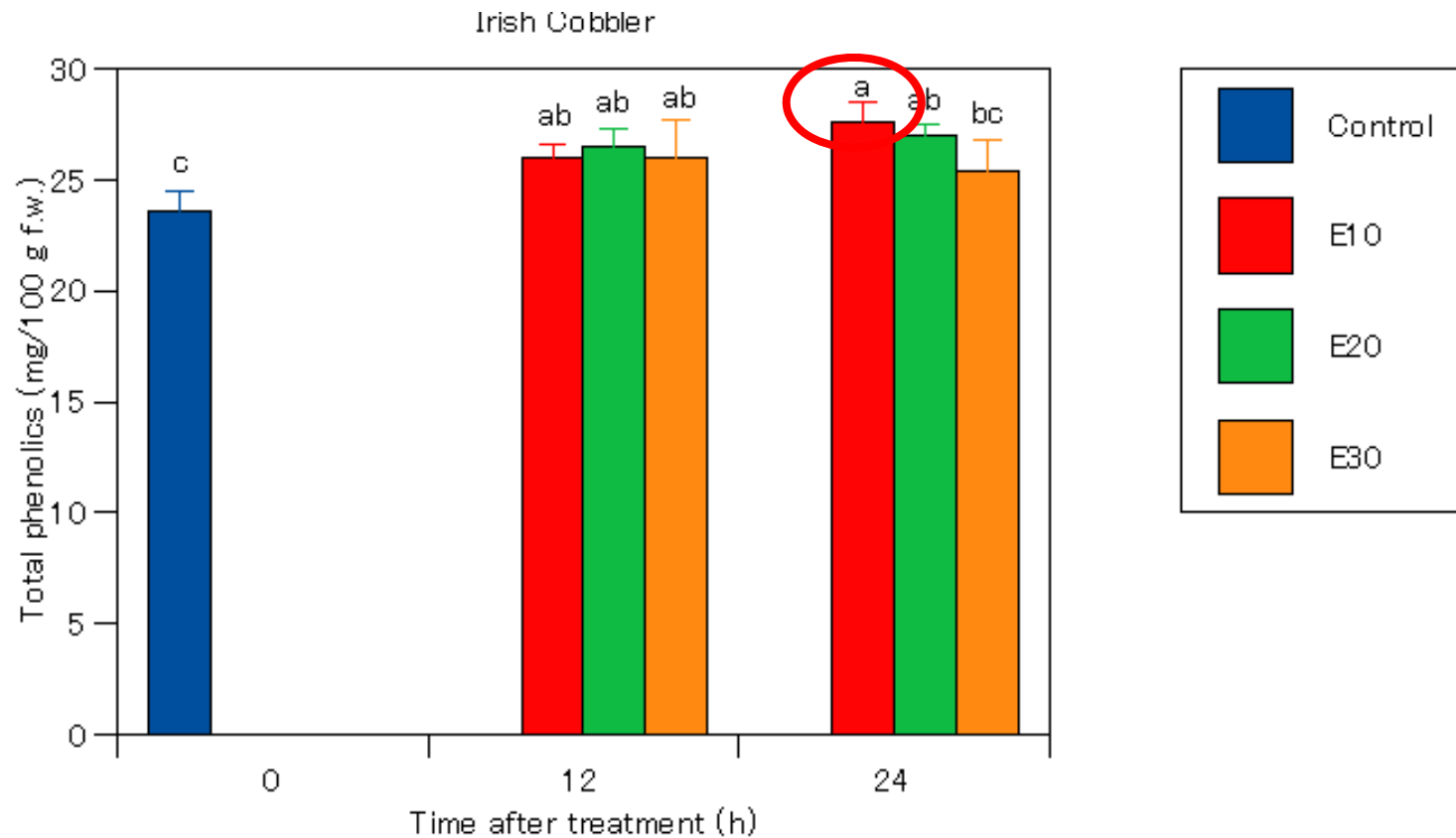


Fig. 5 Effect of electric treatment on total phenolics content of potatoes (Irish Cobbler)

**E10は24時間後，総フェノールを1.2倍増加させた。**

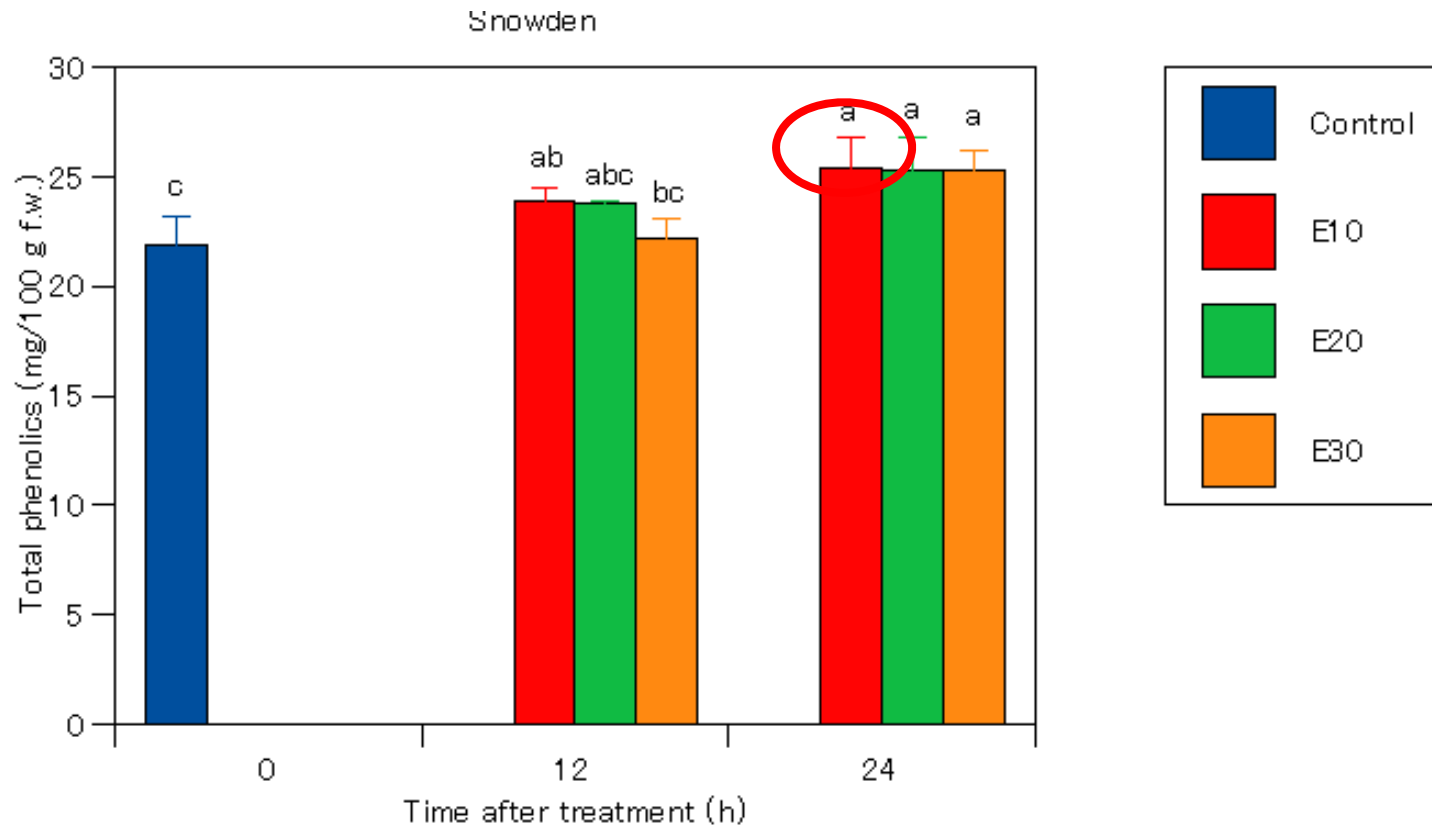


Fig. 6 Effect of electric treatment on total phenolics content of potatoes (Snowden)

**E10は24時間後，総フェノールを1.2倍増加させた。**

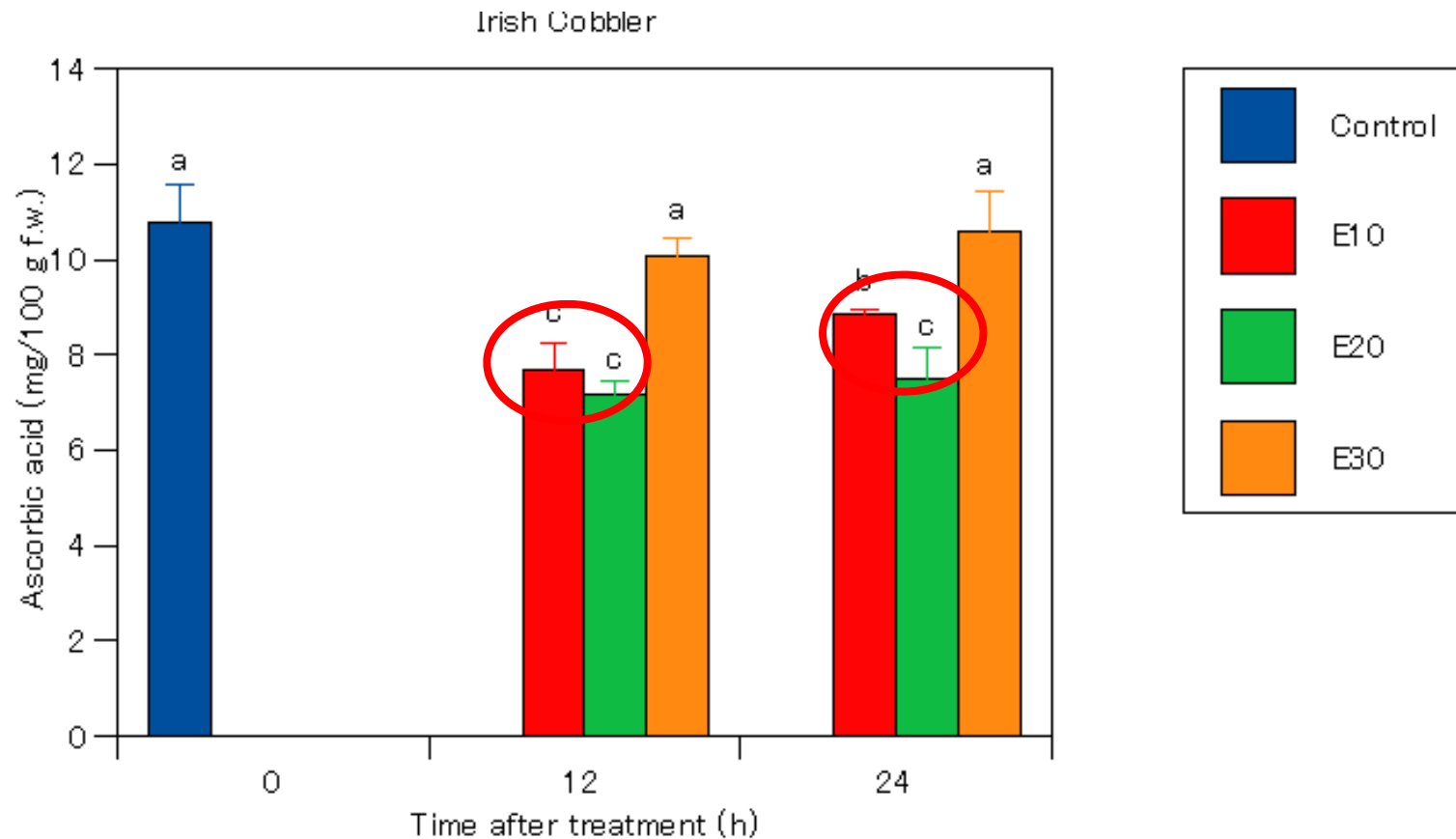


Fig. 7 Effect of electric treatment on ascorbic acid content of potatoes (Irish Cobbler)

E10, E20はアスコルビン酸を  
減少させた。



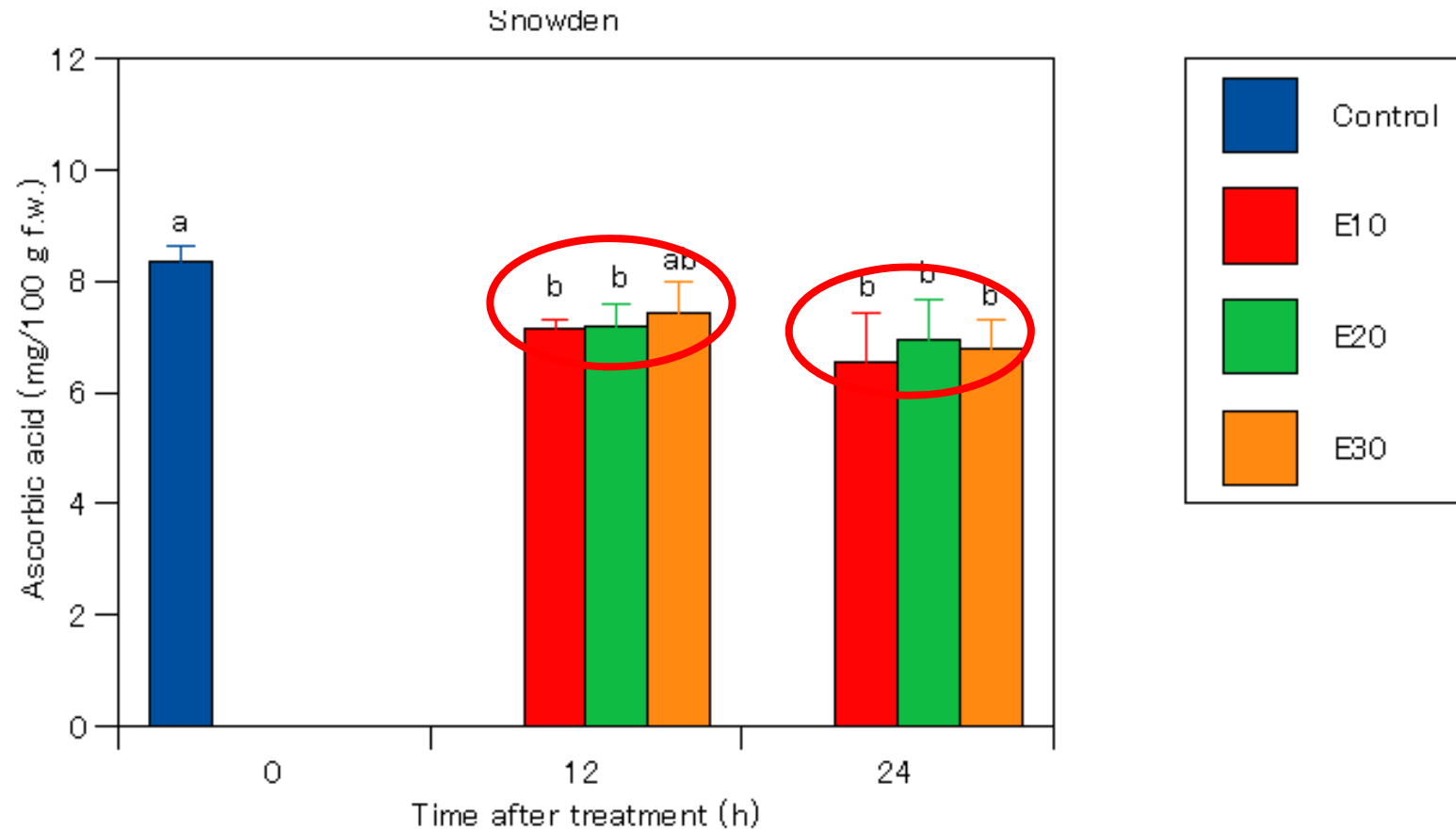


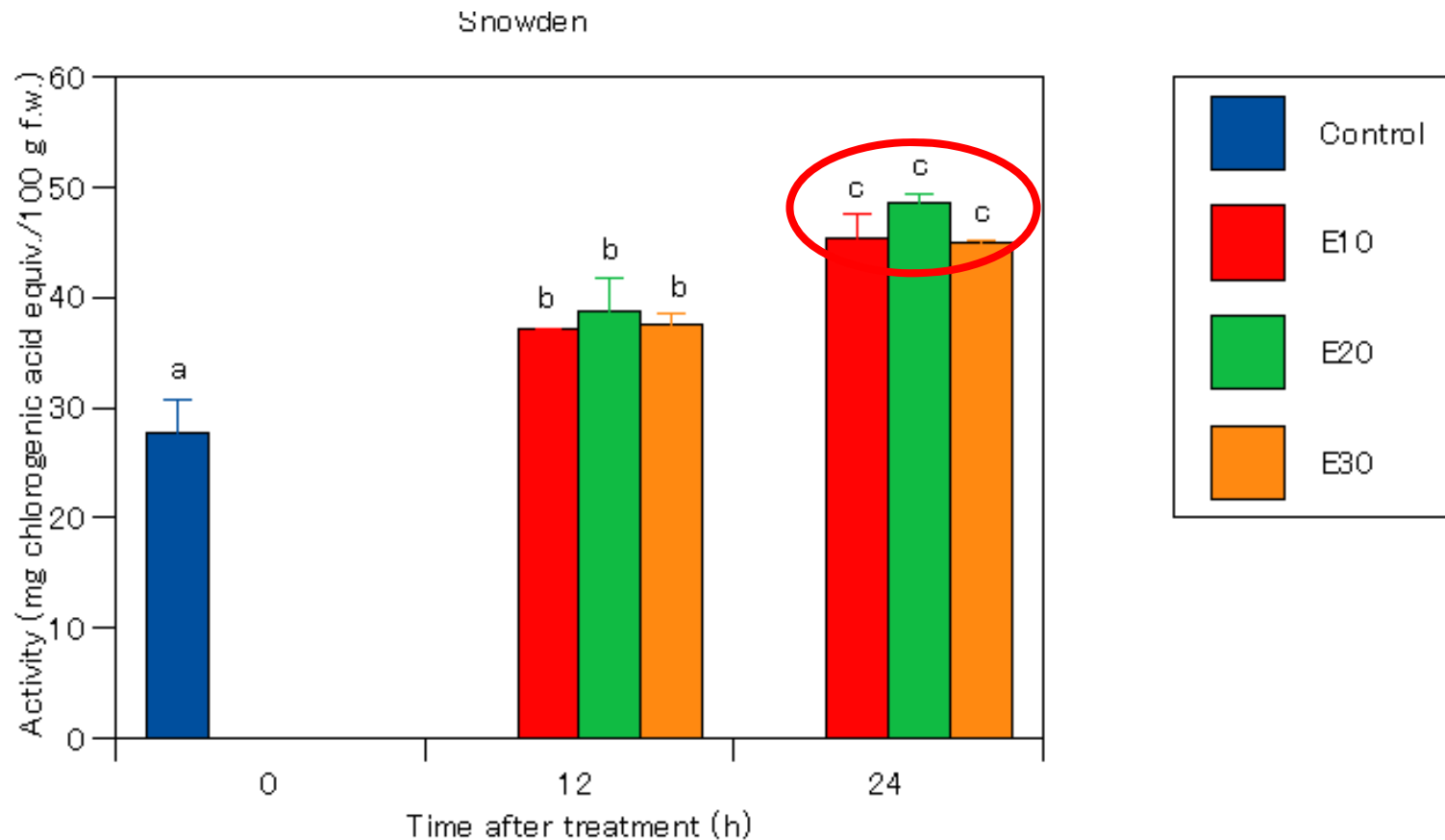
Fig. 8 Effect of electric treatment on ascorbic acid content of potatoes (Snowden)

E10, E20, E30はアスコルビン酸を減少させた。



Fig. 9 Effect of electric treatment on antioxidant activity of potatoes (Irish Cobbler)

E10, E20は抗酸化活性を増加させた。  
E20は24時間後, 1.8倍増加させた。



E10, E20, E30は、抗酸化活性を増加させた。

E20は24時間後、1.8倍増加させた。

A wide-angle photograph of a potato field. The plants are in full bloom, with numerous white flowers scattered across the green foliage. The field extends to the horizon under a grey, overcast sky. In the distance, a line of trees and some utility poles are visible. The overall scene is a typical agricultural landscape.

# 結論

1. E10, E20は, 総フェノール含量を24時間で, 1.2倍増加させた。
2. E20は, 抗酸化活性を24時間後, 1.8倍増加させた。
3. 電気処理は, 抗酸化活性を簡便に増加させる有用な手段であり, 今後の研究が期待される。



TIME



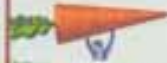
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How to Find a Great Device for the Workplace

### Can Zapping Potatoes Make Them More Nutritious?

Photo by NICK PANK / Science Photo Library

1 Comment • **Related Topics:** Diet & Fitness Nutrition, antioxidants, Cancer, food, heart, nutrition. Zapping potatoes a good way to get water-soluble vitamins that don't cook out, but zapping them to cook a bit and then zapping them with a job of electricity is hardly a conventional culinary trick—ever in the name of molecular gastronomy.

But that's exactly what researchers at Chiba University in Hokkaido, Japan did in an effort to give the spuds more nutritional punch. Zapping potatoes in salt water can make crispier French fries — the salt pulls out the tuber's moisture, leaving behind the starch that gives them their crunch when it's fried. Now the Japanese scientists report that zapping potatoes, or even subjecting them to a few sessions of the high-frequency sound waves from ultrasound, can boost the tubers' antioxidant levels by as much as 20%.

The experiment that Etsuro Hara and his team conducted involved a high school science project — in one, potatoes were placed in a dry salt bathed in water and then subjected to ultrasound for five or 10 minutes. In another study, the potatoes were immersed in a salt water solution and then hooked up with electrodes to receive electrical jolts for 10, 20 and 30 minutes. Compared to uncooked potatoes, those subjected to ultrasound showed 20% more antioxidants, and those treated with electrical current showed 60% greater antioxidant activity.

Antioxidants occur naturally in fruits, vegetables, nuts and grains and can counter the effects of free radicals that break down tissues and contribute to heart disease or cancer. All potatoes contain some antioxidants, which are a rich source of antioxidants, but the white potatoes common in the US — as compared to the yellow, red and purple varieties more popular elsewhere — they possess the lowest levels of these compounds. Boosting those levels, says Hara, could make potatoes a far more nutritious and “functional” food.

But why send currents of electricity coursing through a tuber? Frozen plants under stress in the environment, says Hara, such as from drought, physical trauma and climate changes, effectively pump out more antioxidant plants and chemicals and to some of the damage done results are more or less. The electricity and ultrasound waves are a lab-based way to mimic that stress.

His crew is left experimenting with an electrode on the kitchen counter quite yet. Indeed, that was happens, researchers need to better understand the way that stress and ultrasound change the characteristics of potatoes. That could one day help growers and manufacturers make more out of a potato than French fries.

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By Nick Jones

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Video



How to Choose the Best Golf Course in Your Area

A wide-angle photograph of a potato field. The plants are in full bloom, with numerous white flowers scattered across the green foliage. The field extends to the horizon under a grey, overcast sky. In the distance, a line of trees and utility poles are visible. The overall scene is a typical agricultural landscape.

# 考察

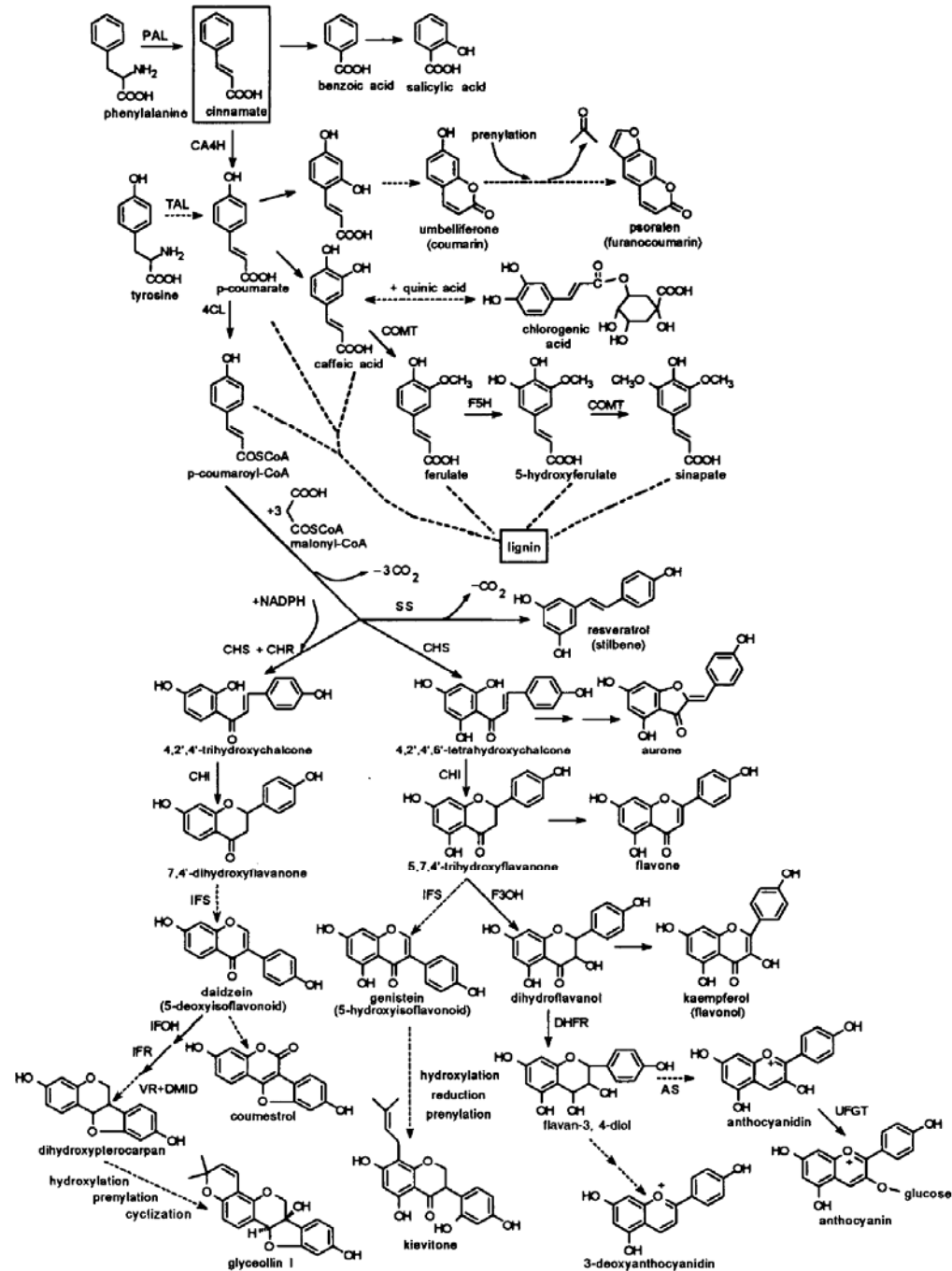


Figure 1. Biosynthetic Relationships among Stress-Induced Phenylpropanoids.



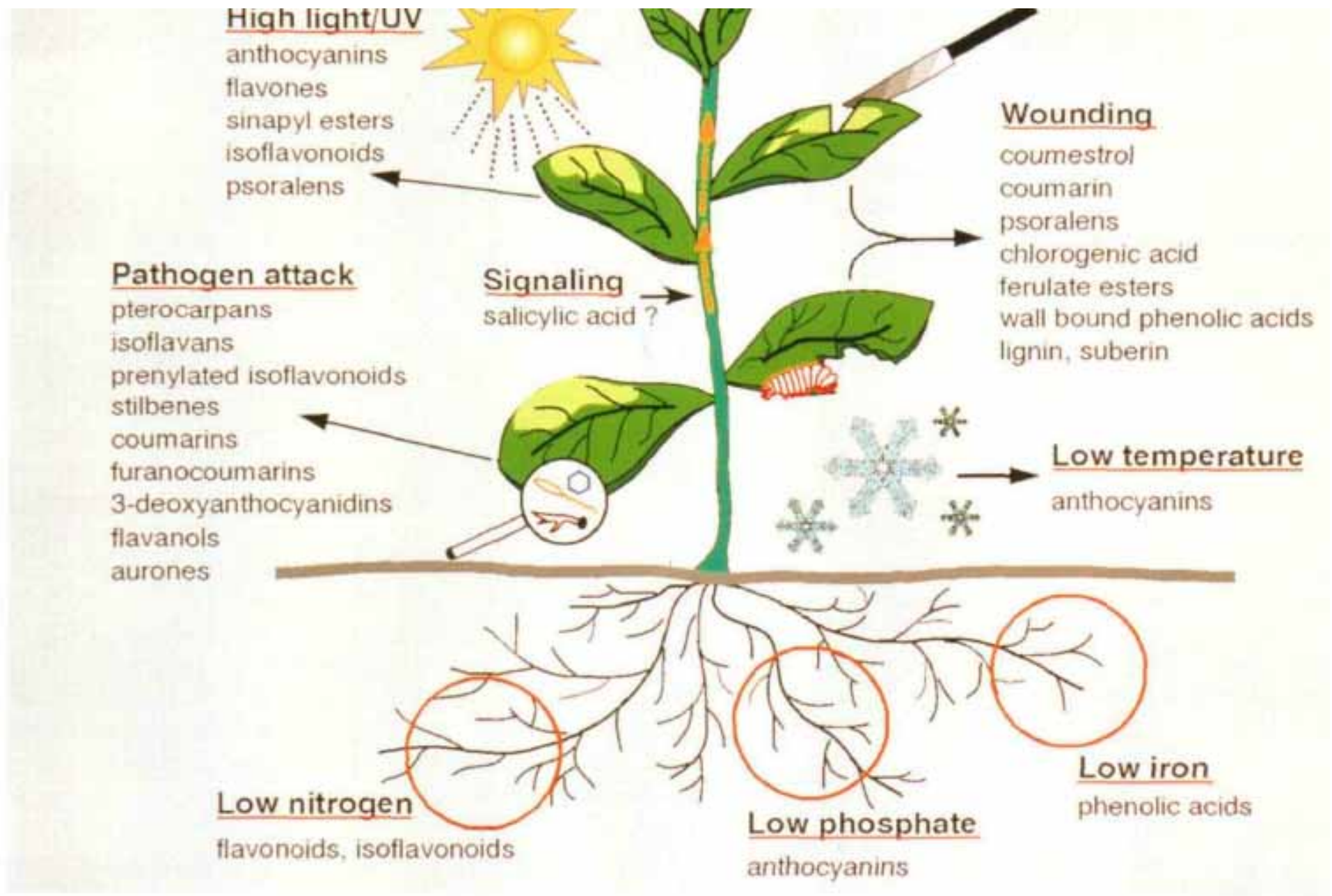


Figure 2. Examples of Stress-Induced Phenylpropanoids.

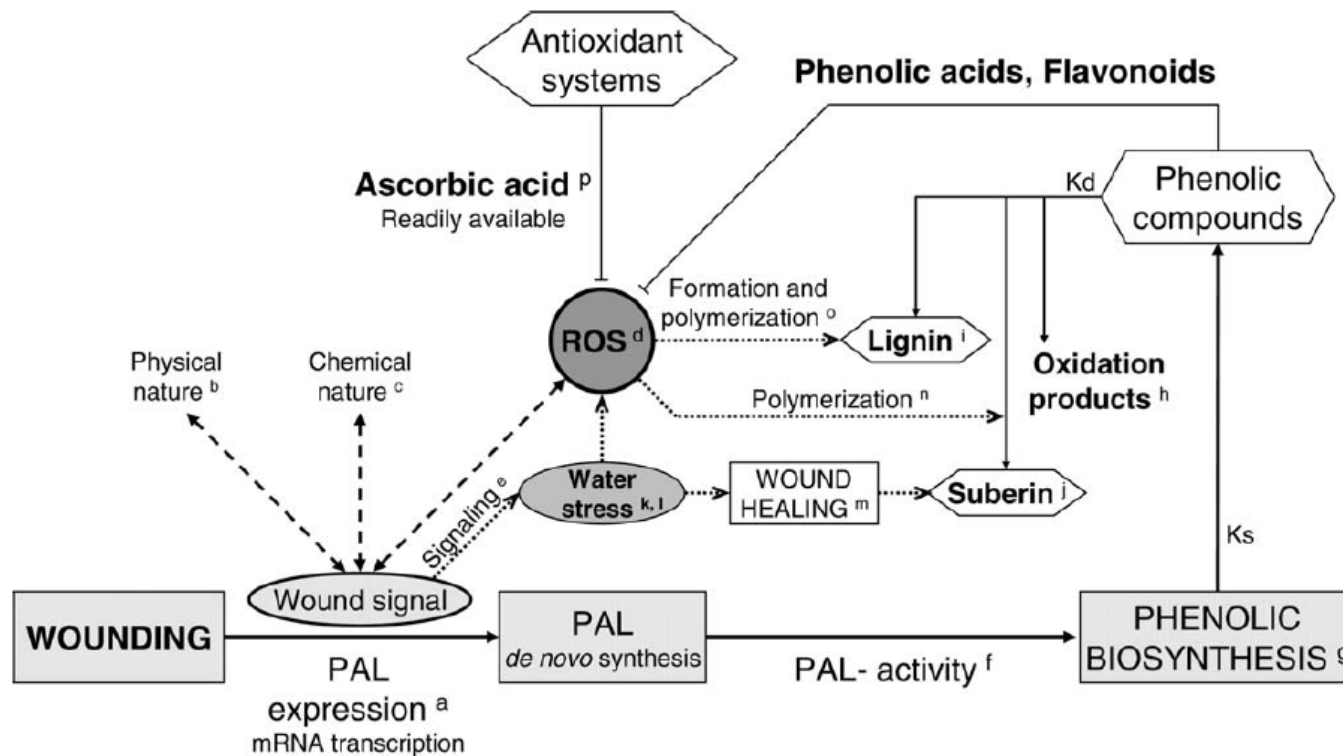
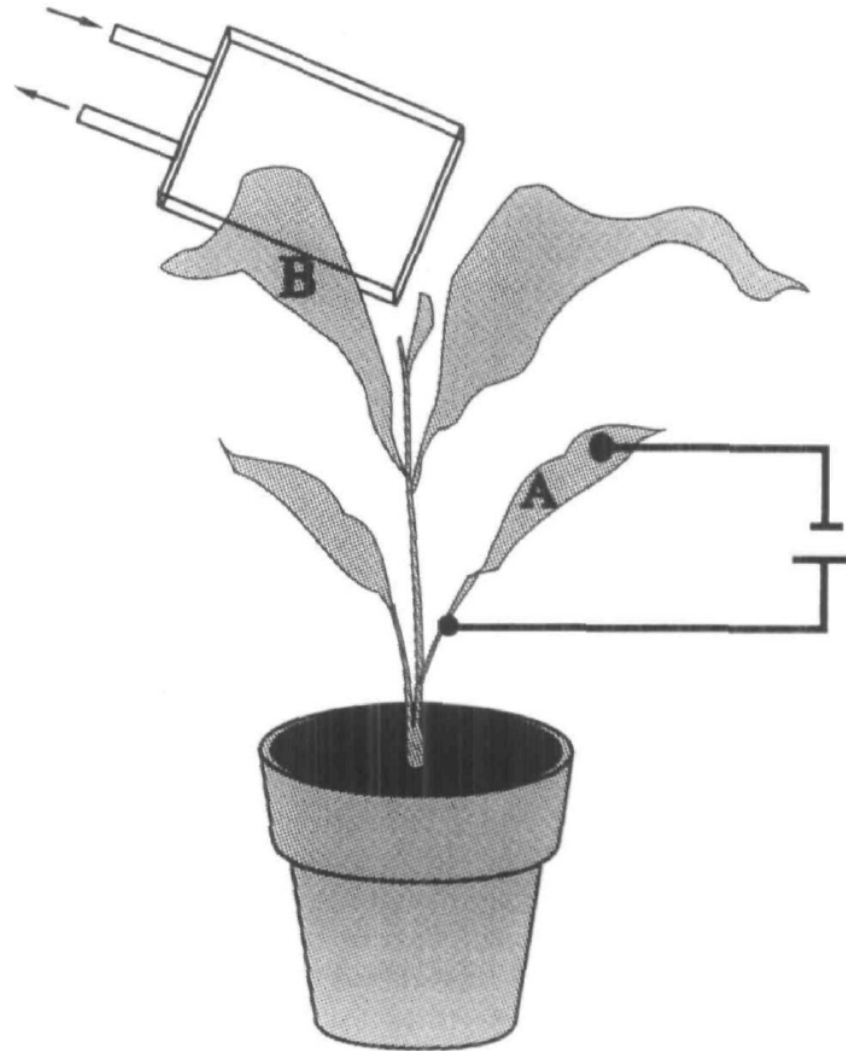


Fig. 4. Proposed mechanism of action of wounding stress and roles of reactive oxygen species (ROS) and antioxidants within the plant cell.  $K_s$  and  $K_d$  refer to phenolic synthesis and decrease rate, respectively (refer to Section 3.1). Superscripts a–p refer to literature references: (a) Kang and Saltveit (2003); (b) Malone and Alarcón (1995), Saltveit (1997); (c) Saltveit (1997), Campos-Vargas and Saltveit (2002); (d) Orozco-Cárdenas et al. (2001); (e) Reymond et al. (2000); (f) and (g) Dixon and Paiva (1995); (h) Talcott and Howard (1999); (i) Tamagnone et al. (1998); (j) and (m) Bernards et al. (1995); (k) Smirnoff (1993); (l) Jiang and Zhang (2002); (n) Razem and Bernards (2002); (o) Ros (1997); (p) Buettner (1993).



**Fig. 1** Experimental setup. A represents the local leaf, B the non-treated systemic leaf. All types of stimulation were applied to the leaf A, and gas exchange measurements were performed on leaves A and B.

A photograph of fresh vegetables arranged in a woven basket. On the left are several green bitter melons with their characteristic bumps. In the center and right are several okra (ladyfinger) vegetables. Behind the okra is a bundle of ginger roots. The basket is set against a blurred background of green foliage.

# 今後の研究



1. 他の農産物での挑戦（操作条件設定）

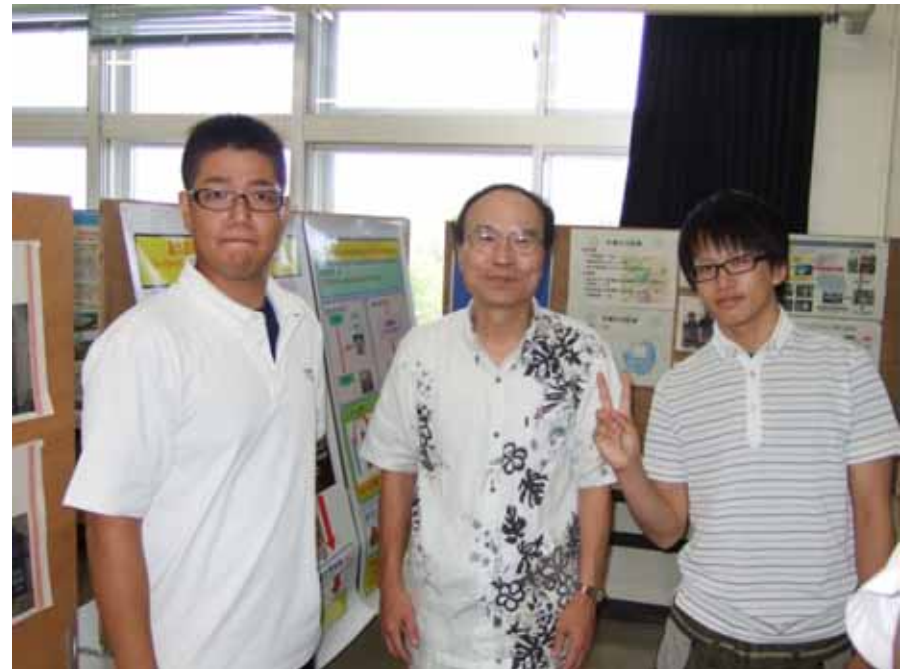
2. 交流 or 直流







若い学生さんと共に，世界に発信します。

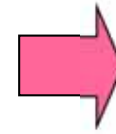
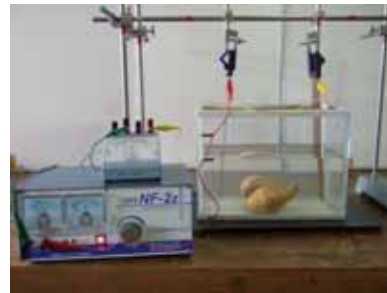
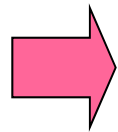


御静聴ありがとうございました。





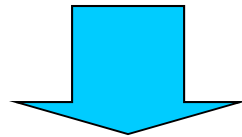
# Enrichment of antioxidant activity in sweet potato by electric treatment



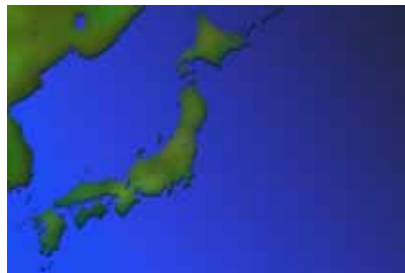
**Kazunori Hironaka**

**Background**

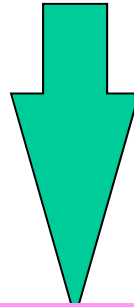
(Sweet potatoes of 1 million tons are harvested in **Japan. Okinawa** (the northern part in Japan) is a famous area, especially for **purple-colored** sweet potato)



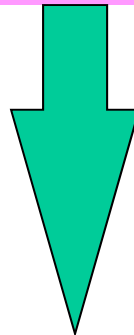
**seventh**



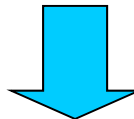
**Consumer interest**



**Health benefits**



**Functional Foods**



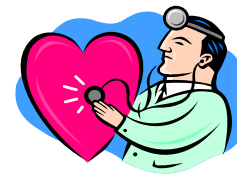
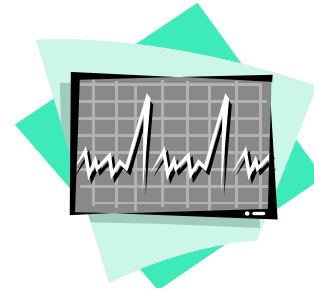
**\$48 billion market**

**Functional Foods**



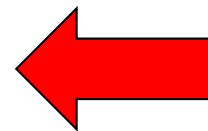
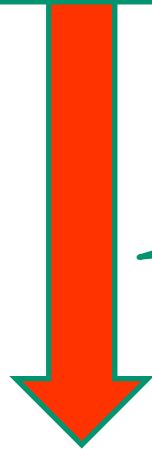
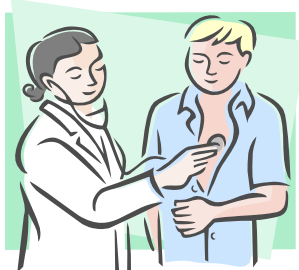
**\$48 billion market**

**heart disease,  
cancer**

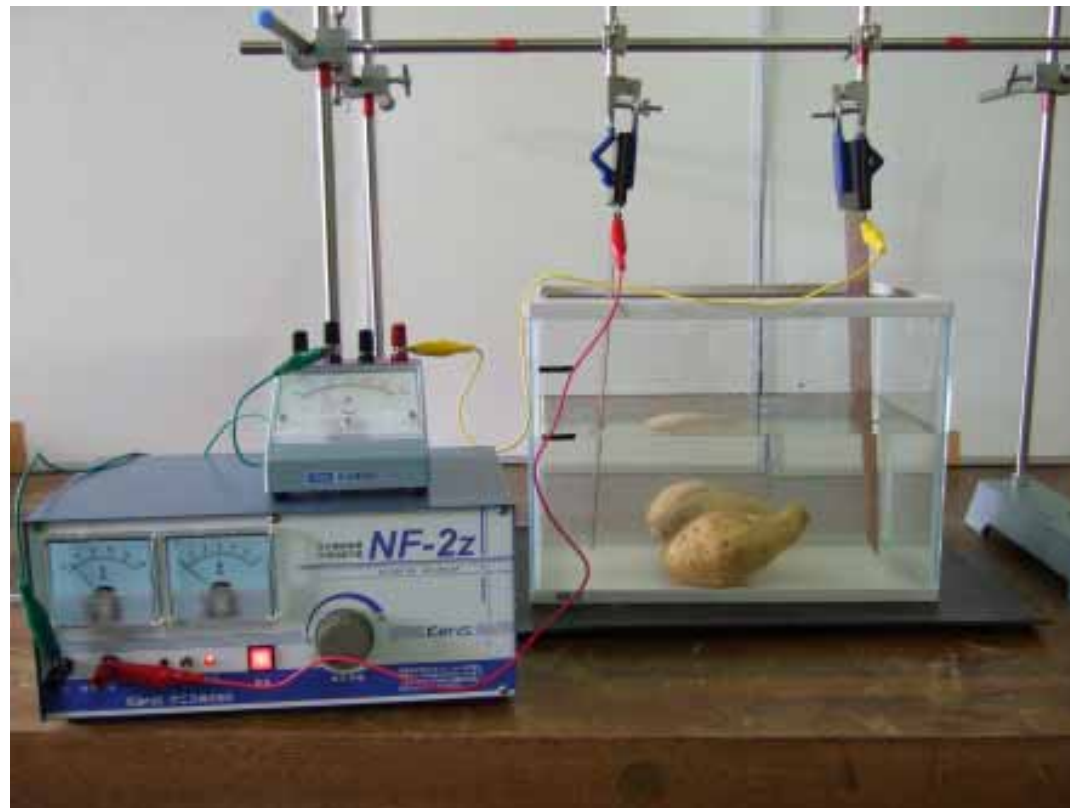


**Enrichment by ultrasound  
or electric treatment**

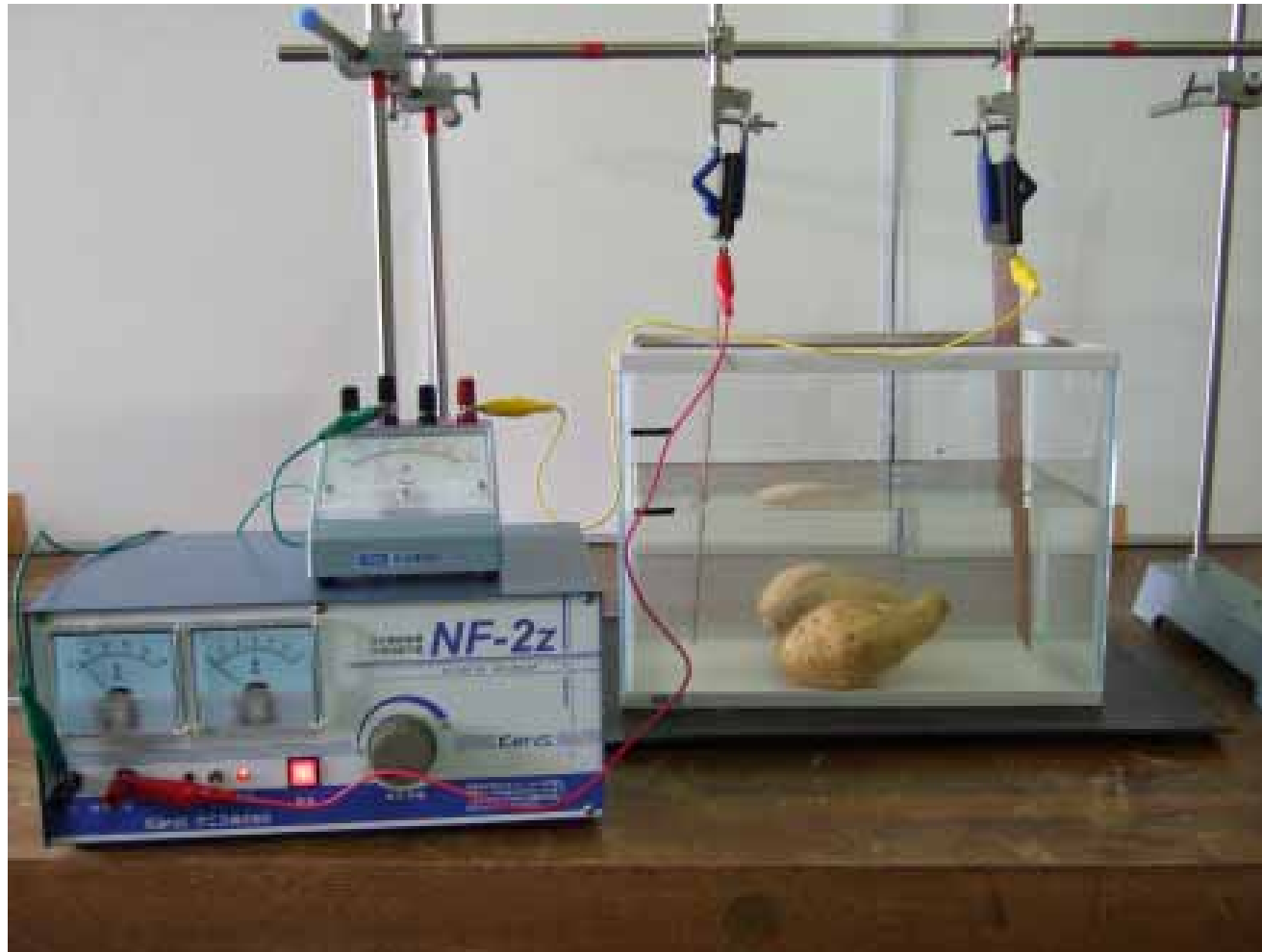
**Healthy life**



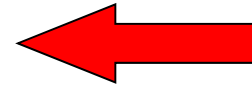
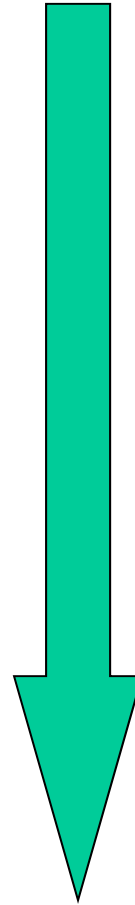
**No studies exist on electric treatment to improve health function of sweet potatoes .**



# Electric treatment



# Sweet potatoes



Electric  
treatment  
(ET)

Nutritionally enriched sweet  
potatoes?



**Potatoes**

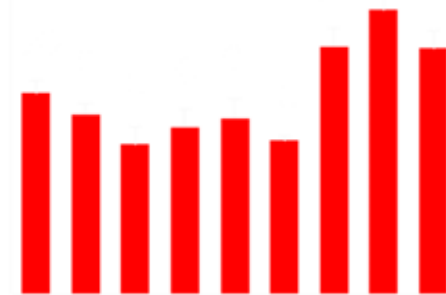
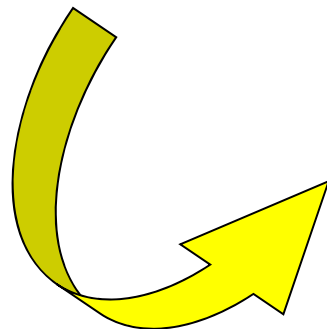
ET treatment



**Treatment  
OK or Not ?**

**Purpose**

The **present study** was initiated to evaluate the use of **ET** for **enriching antioxidant** activity of sweet potatoes.



# Materials and Methods

# Samples and Storage

**Bise variety**

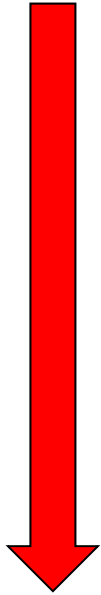


Harvest date: Nov. 2011

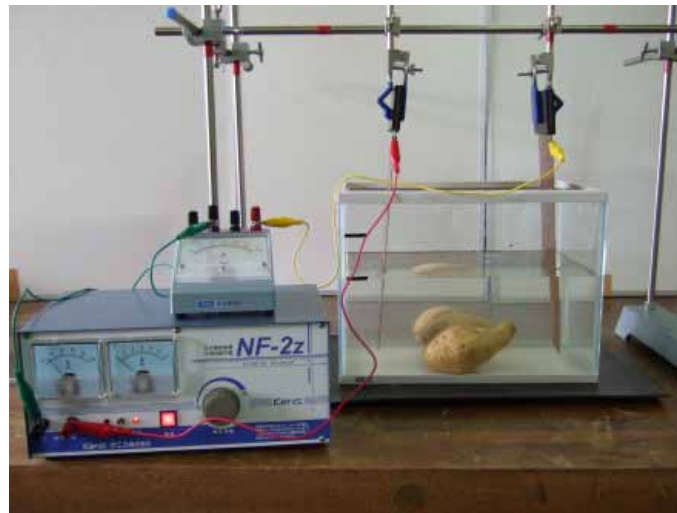
Storage: 20°C for 1 months

# Electric treatment (ET)

potato



ET





**Treatment time  
(5 min)**



**Time after the treatment  
(24 hr)**

## Analytical method

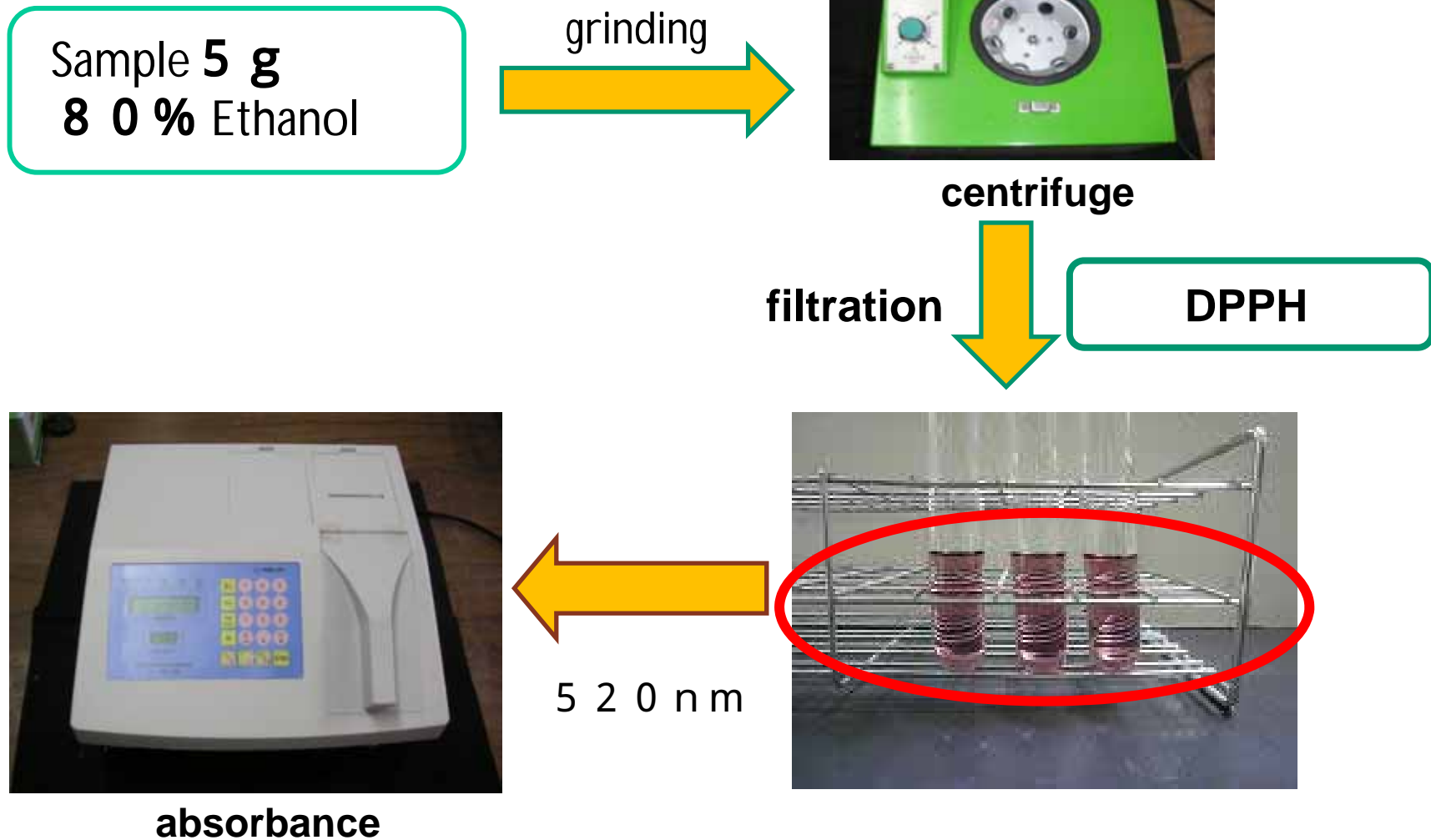
Total phenols : Folin–Ciocalteu

Antioxidant activity : DPPH

Soluble solid : Refracto meter



# Antioxidant activity



# Total polyphenol

Sample **5 g**  
95% Ethanol

grinding



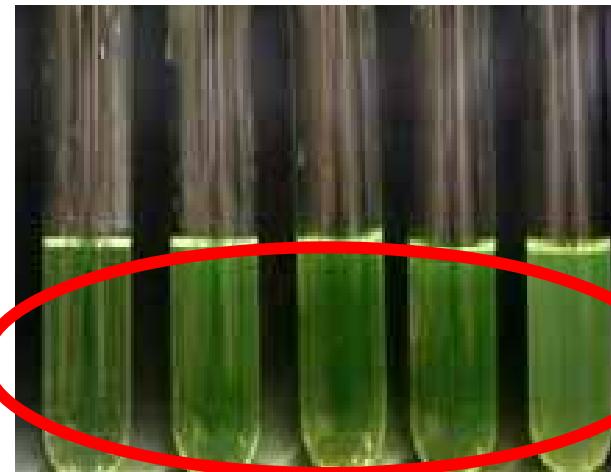
filtration

Folin-Ciocalteu  
 $\text{NaHCO}_3$



absorbance

725 nm



# Soluble solid

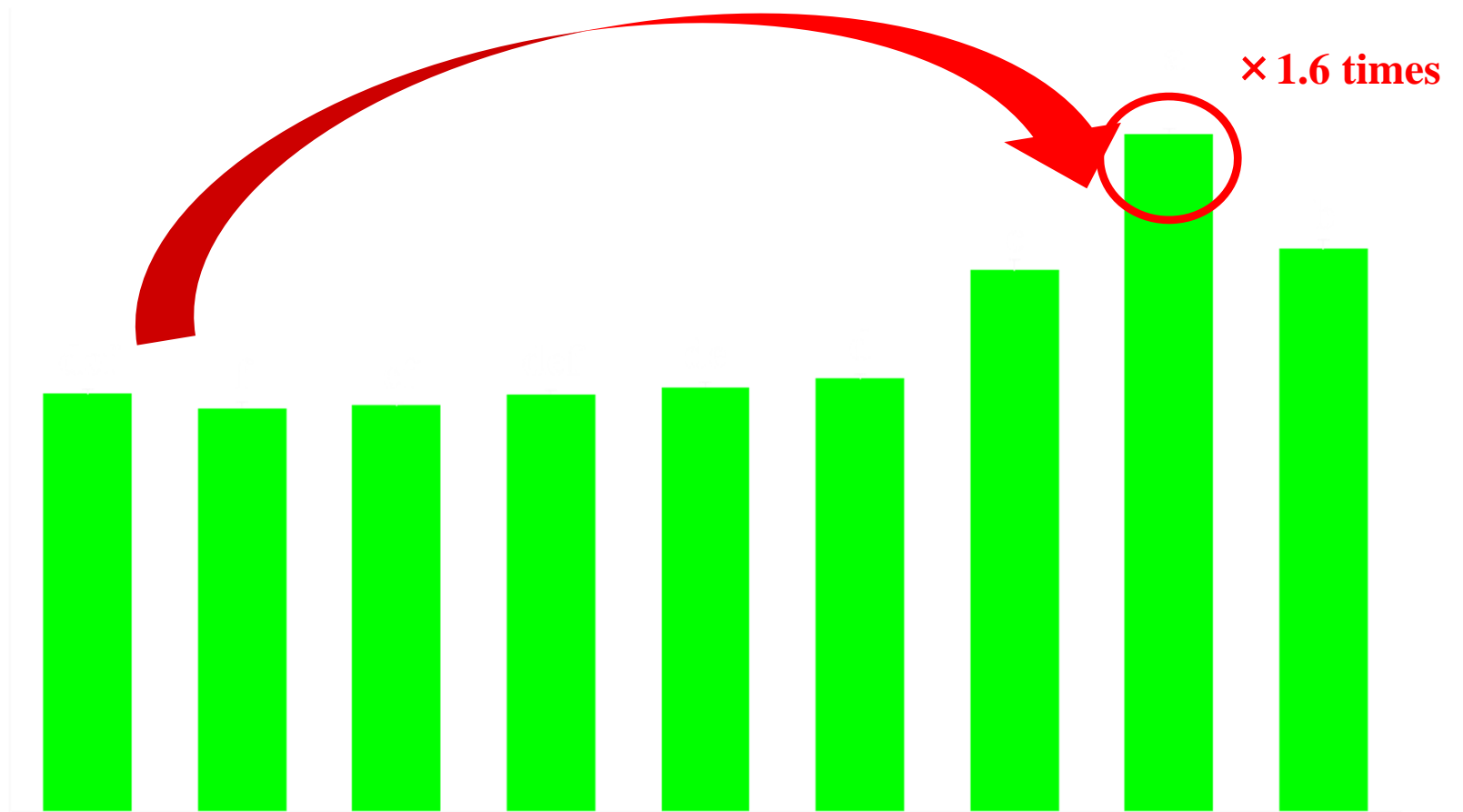
- Brix



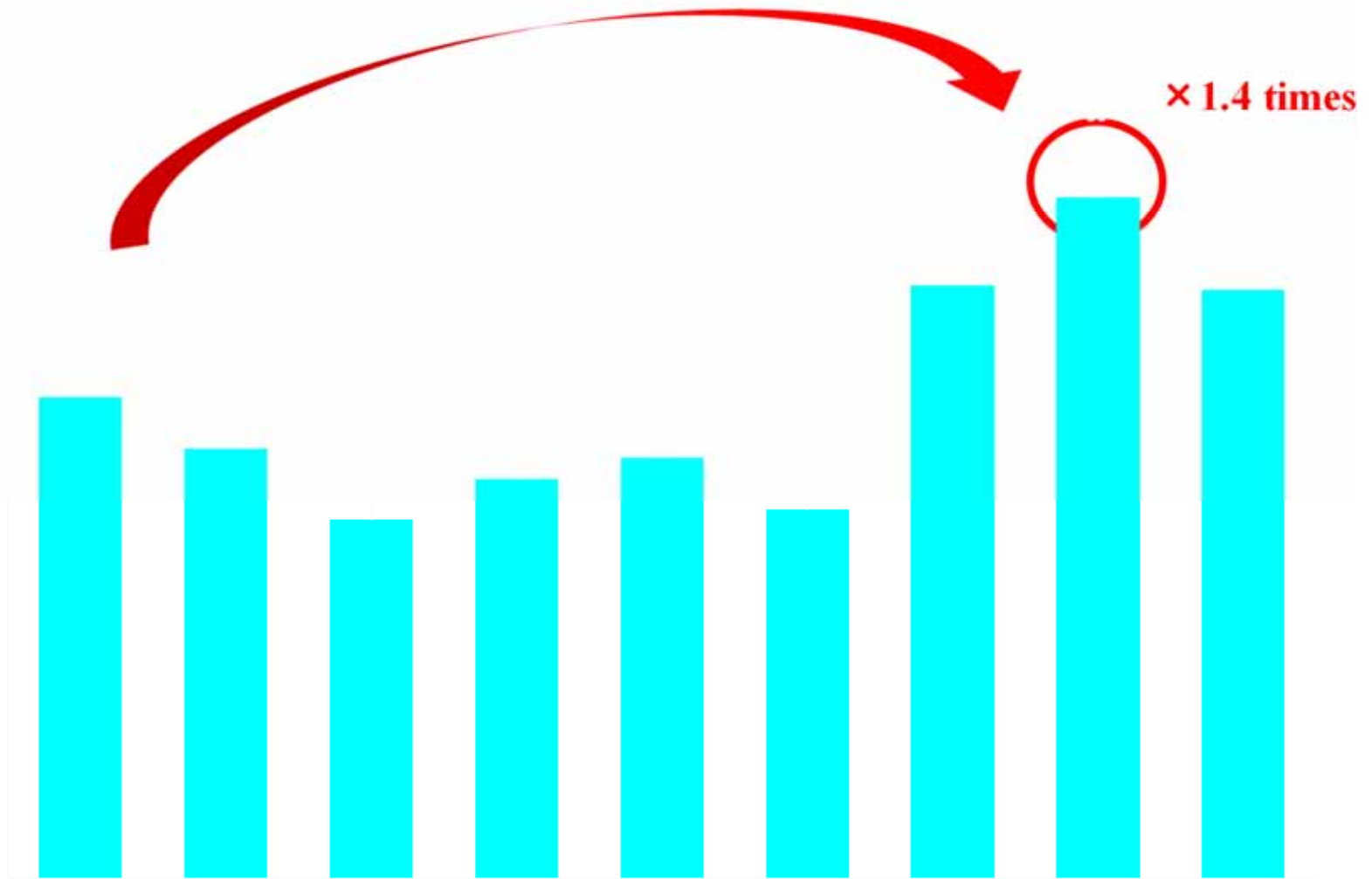
**ATAGO**  
**DIGITAL REFRACTOMETER**  
**PR-1**



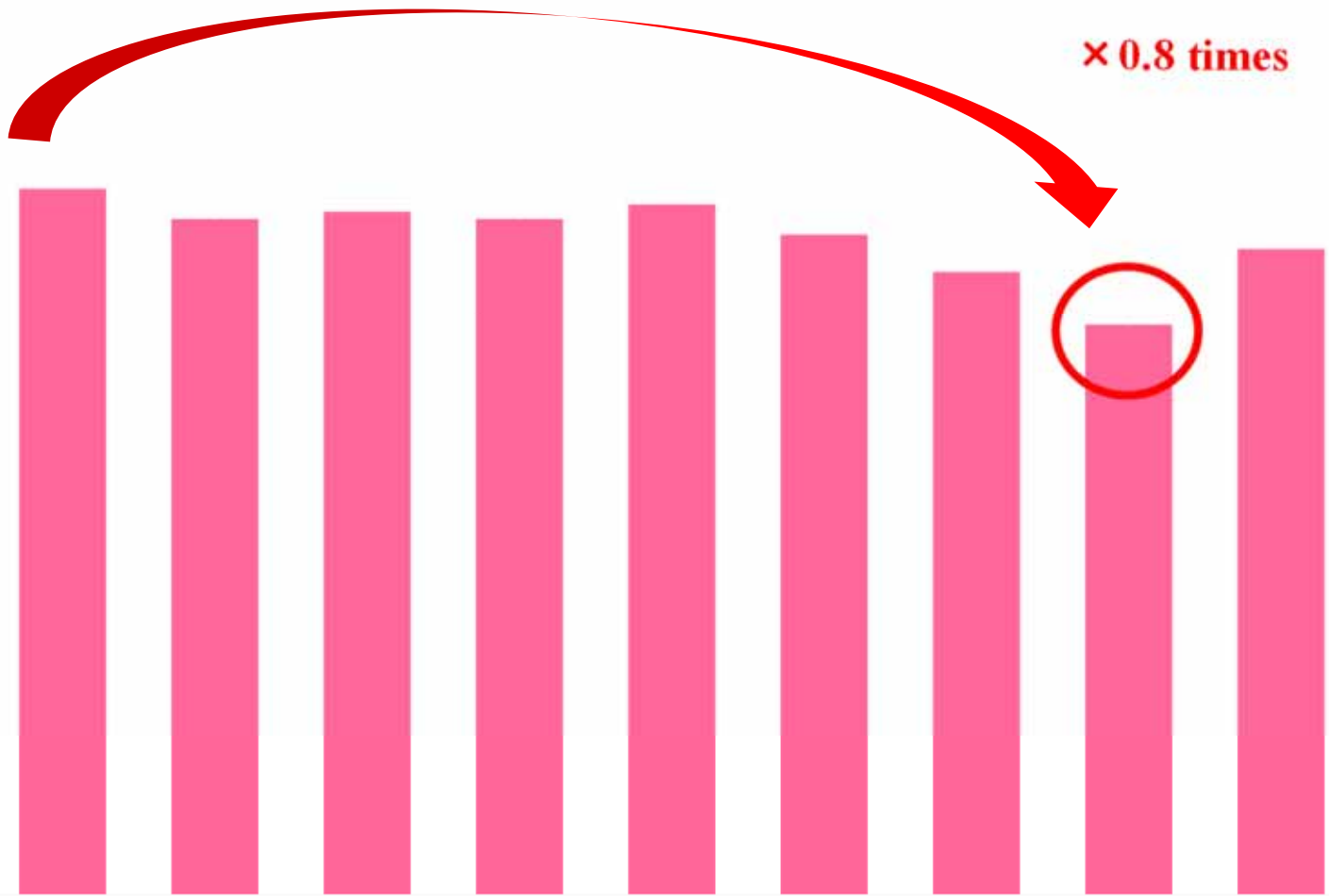
# Results



Maximum at 200 mA



Maximum at 200 mA

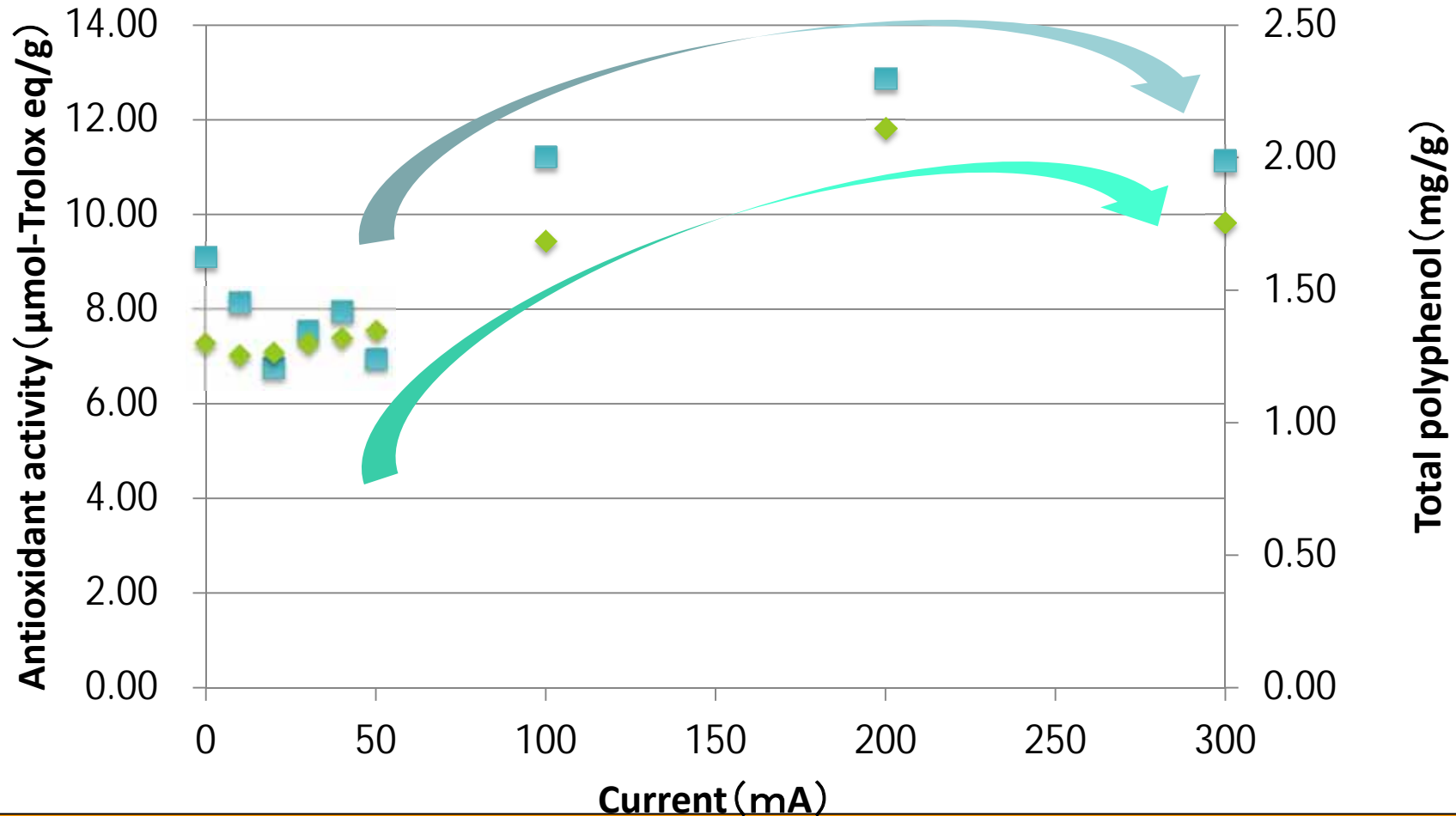


Minimum at 200 mA



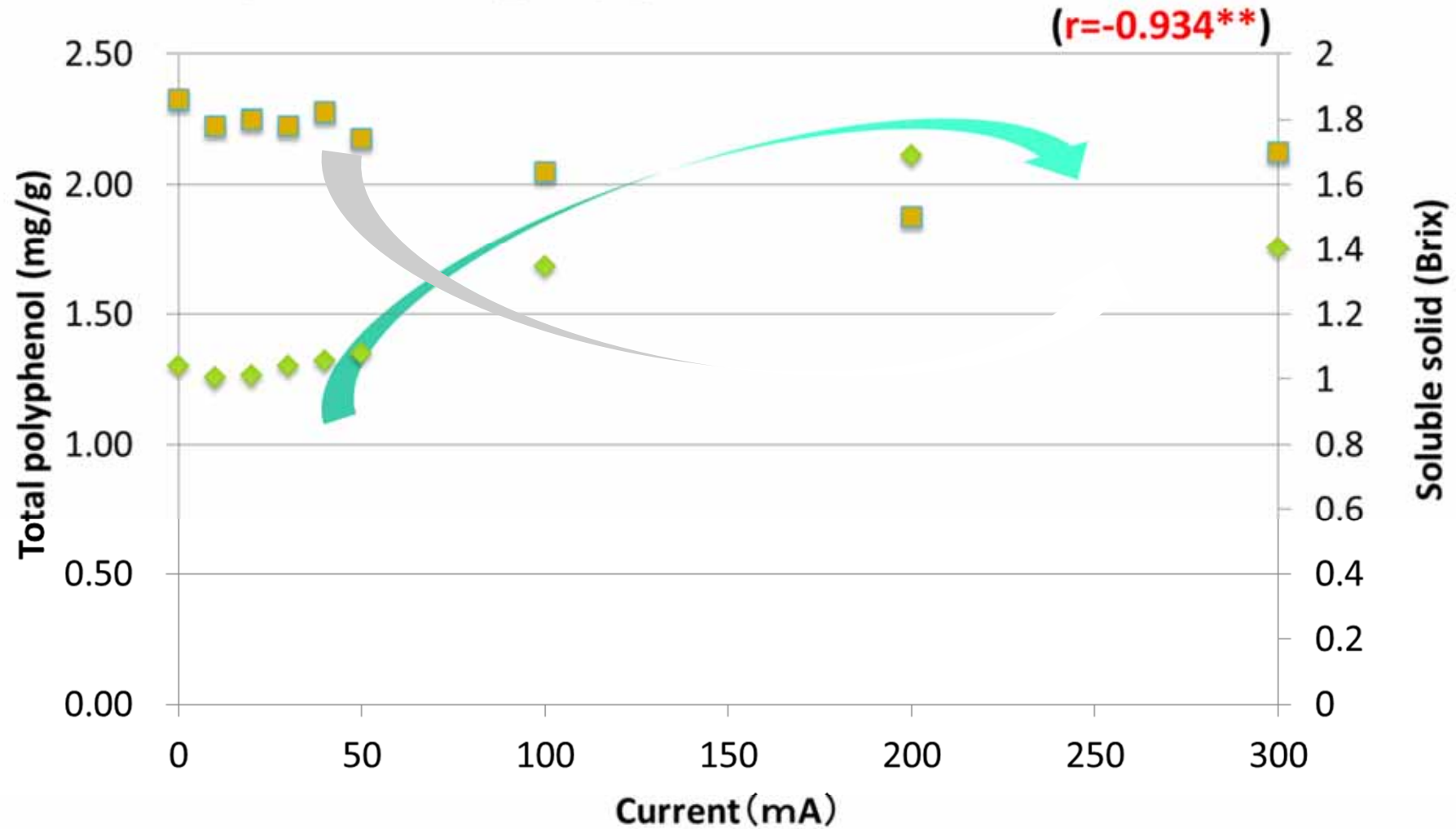
# Fig.4 Antioxidant activity & total polyphenol

( $r=0.931^{**}$ )



Positive relation between antioxidant activity and polyphenol

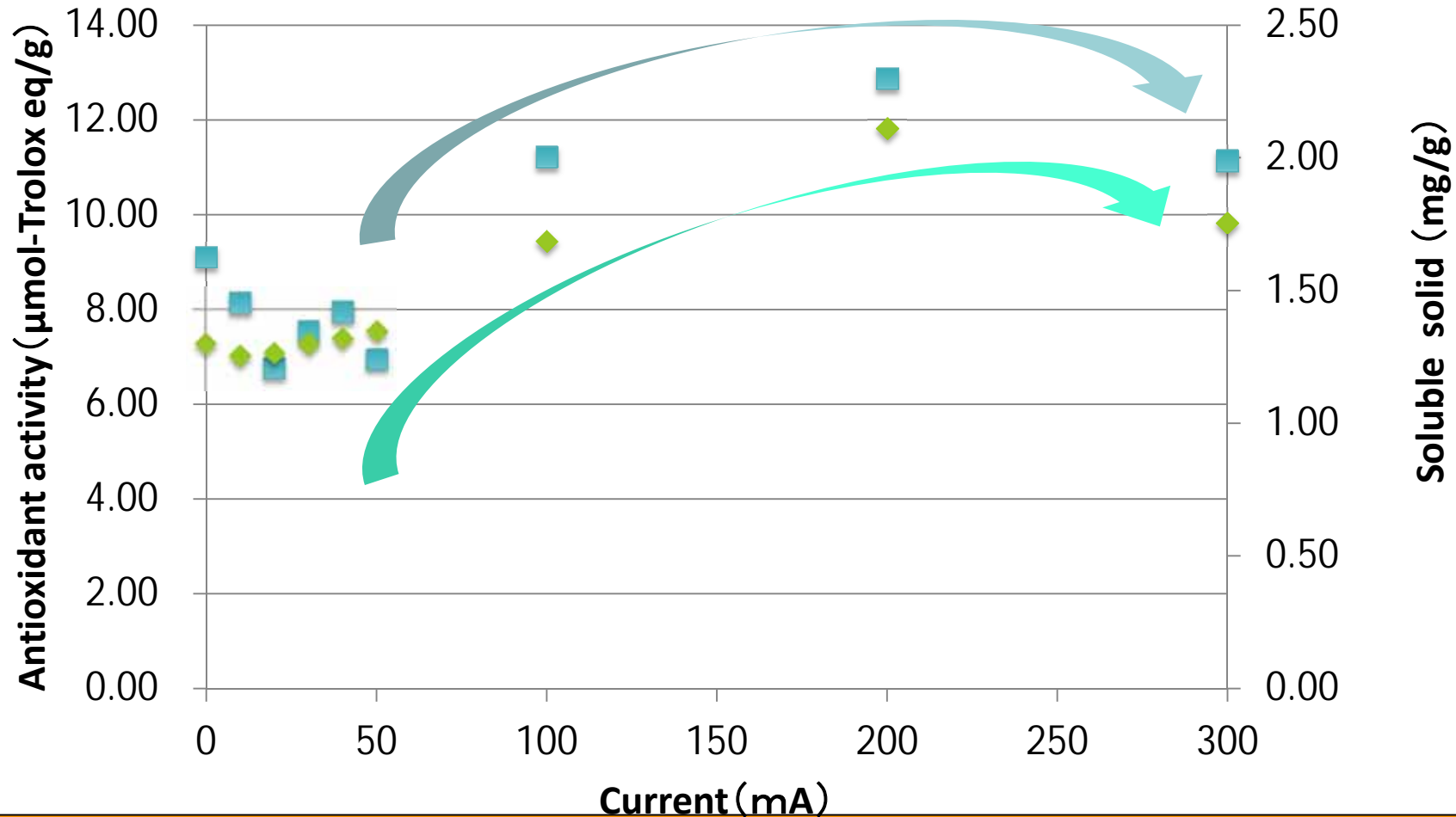
# Fig.5 Total polyphenol & soluble solid



Negative relation between total polyphenol and soluble solid

# Fig.6 Antioxidant activity & soluble solid

( $r=0.806^*$ )



Positive relation between antioxidant activity and polyphenol

# Discussion

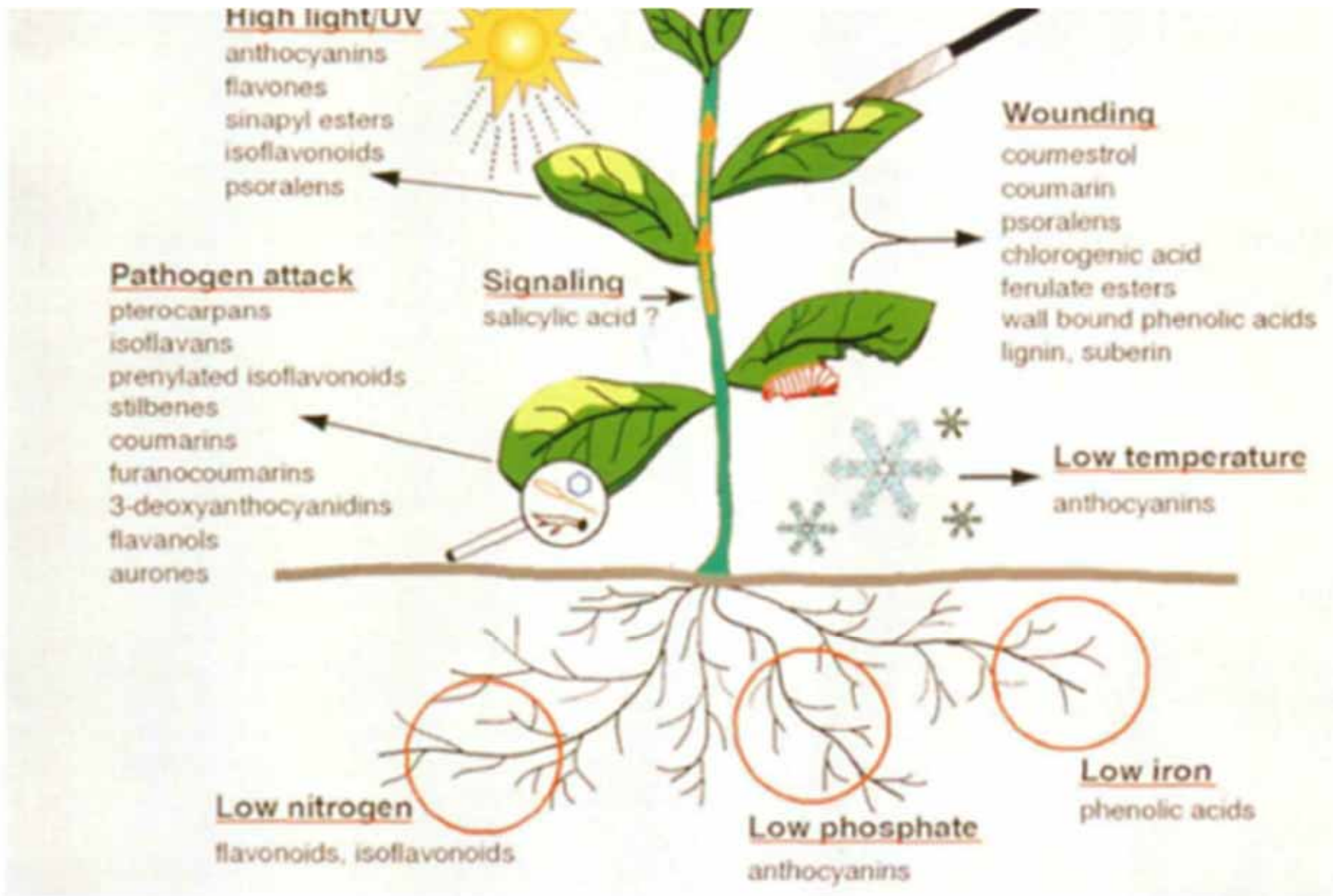
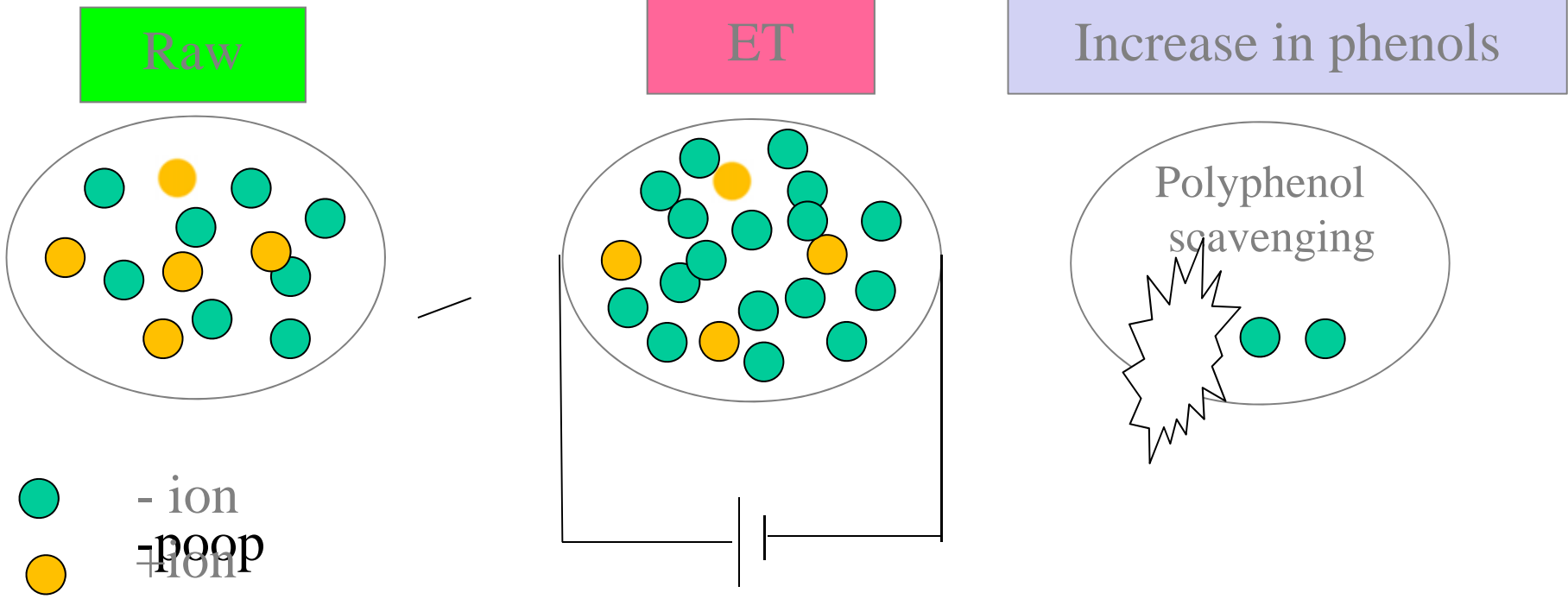
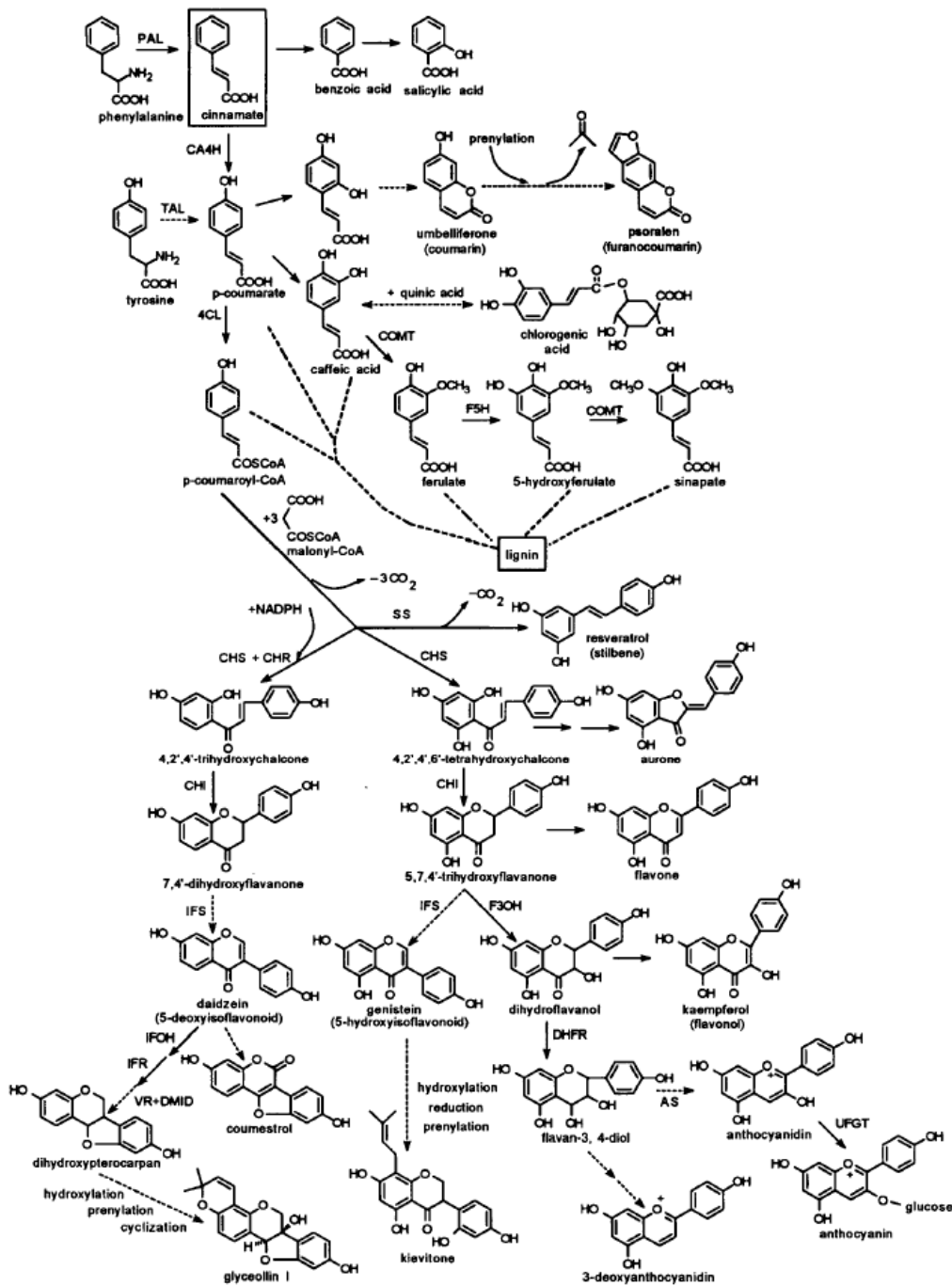


Figure 2. Examples of Stress-Induced Phenylpropanoids.

Stresses and polyphenol

# Model of electric treatment





Polyphenol synthesis

# Conclusion



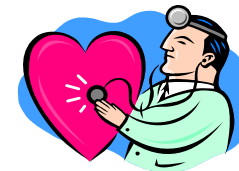
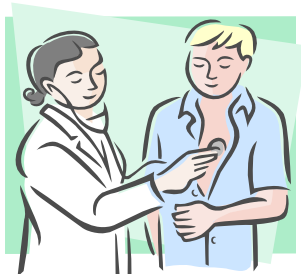
**1. No changes were observed in total polyphenol between 0 and 50 mA current levels.**

**2. The 200 mA current charge increased the total polyphenol 1.6 times as compared with non-treatment.**

**3. The 200 mA current charge also increased the antioxidant activity 1.4 times as compared with non-treatment.**

**4. The 200 mA current charge also decreased the Brix level 0.2 times as compared with non-treatment.**

5. This study indicated that **ET** treatment was **useful** for **enriching** the **antioxidant activity** of sweet potatoes with **non-desructive** and **short-time** benefits.



## Further work

**1. Effect of the treatment time on the antioxidant activity**

**2. Direct probe to a sweet potato and its response of the sweet potato**



**3. Direct current and alternating current responses**

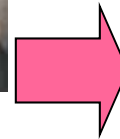
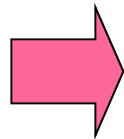
**4. Challenges to other agricultural products**



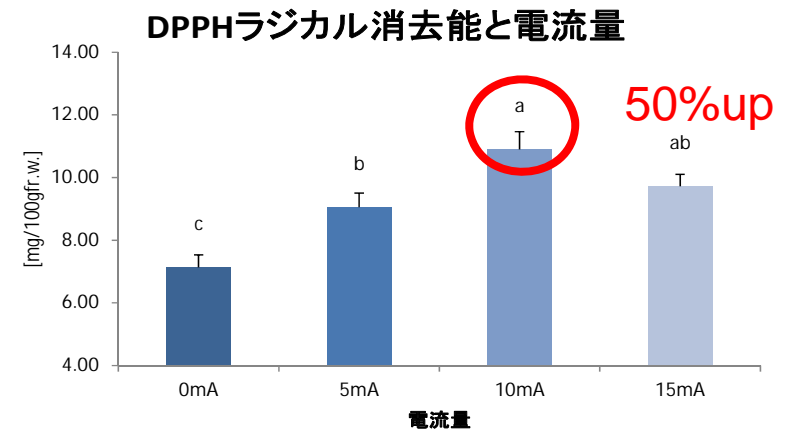
**Thank you for listening  
this presentation.**



# 紅イモの電気処理における電流量 および通電時間が抗酸化活性にお よぼす影響



琉球大 弘中和憲



# 研究背景

沖縄県では紅イモ（沖縄産カンショ）の生産が盛んで、大きな経済効果を生み出している。



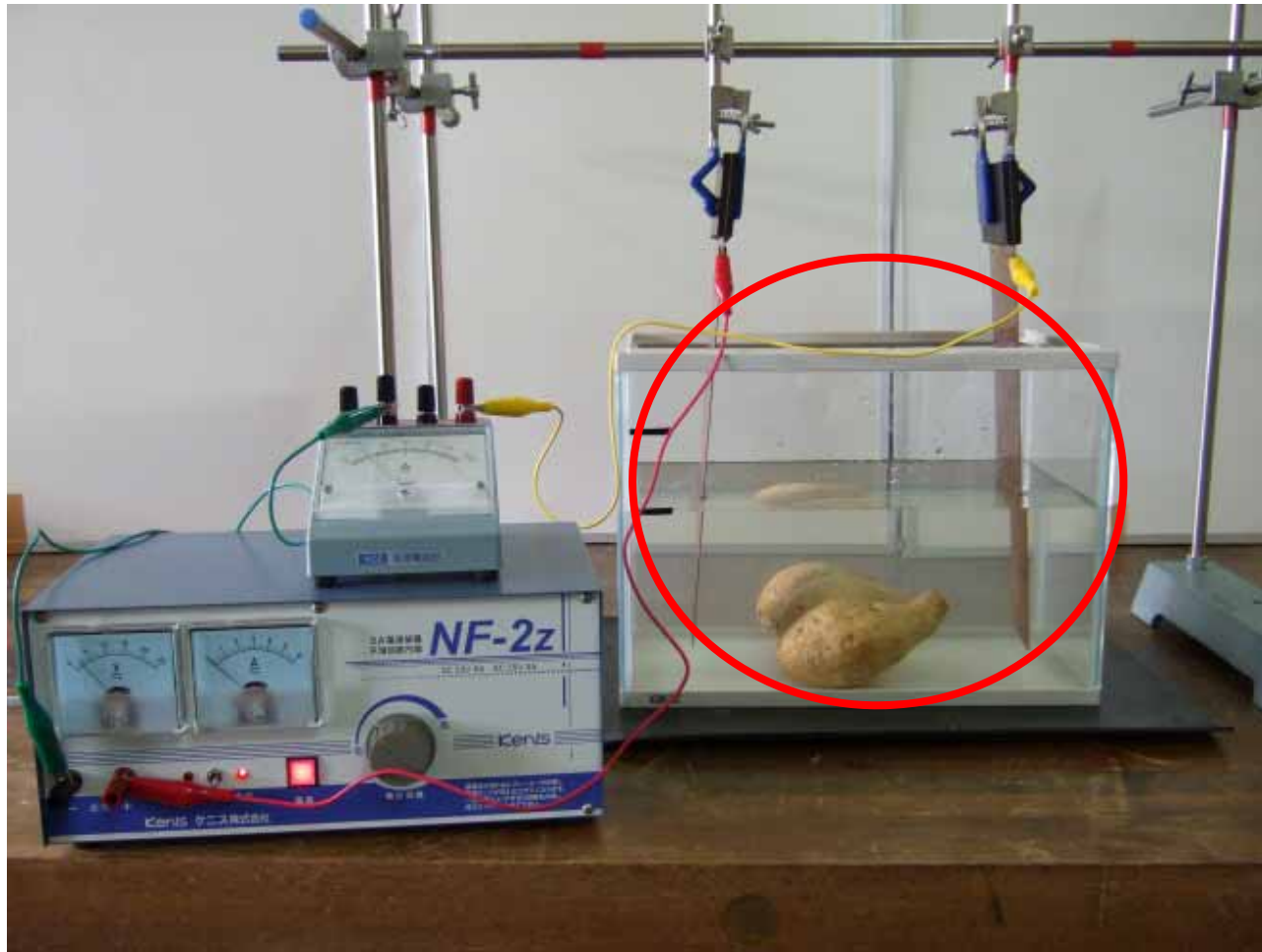
紅イモに付加価値を付けることが出来れば、更なる需要が見込める。



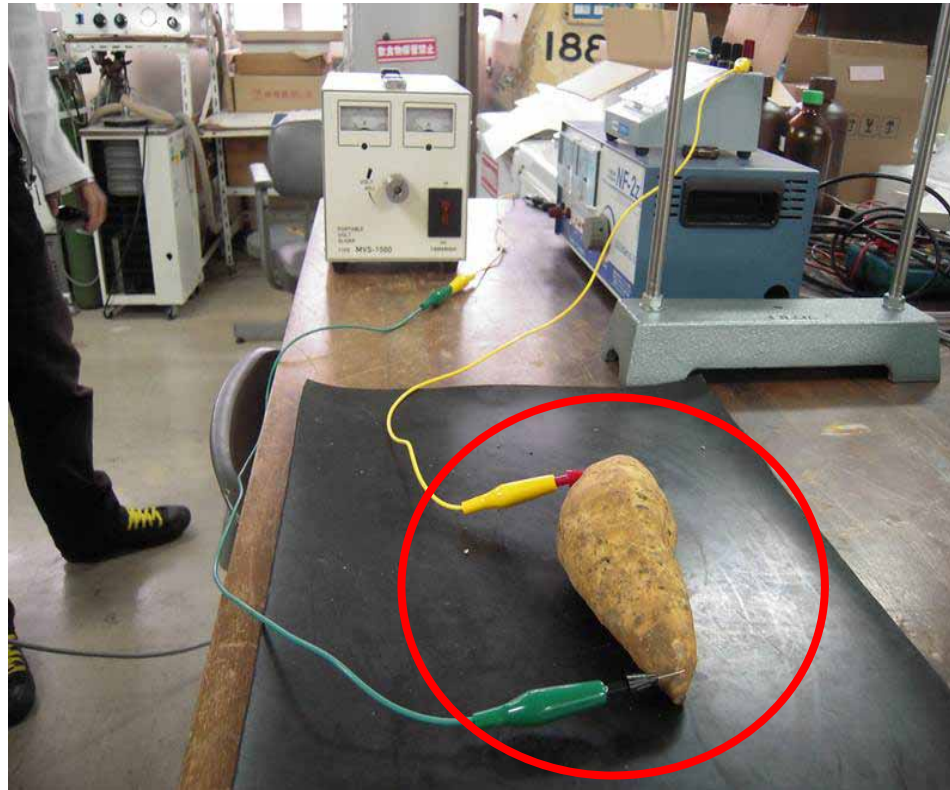
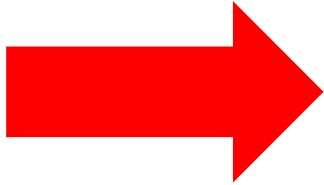
紅イモの電気処理応答性を検討する。



## 電気処理(昨年度)



今年



0.9mm電極を15mm  
差し込む。

# 研究目的

紅イモの電気処理応答性を検討し、機能性増強を図る。

# 検討項目

## 1.内観

電気処理によって、**内観が変化**するかを確認する。

## 2.処理電流量と通電時間の影響

電気処理の電流量と通電時間の変化によって紅イモの成分（DPPHラジカル消去能、総ポリフェノール量、含水率）がどのように**変化**するかを確認し、**適切電流量と通電時間**を特定する。

## 3.中心と皮付近の成分の差異

最適条件で電気処理を行い、**中心と皮付近**のDPPHラジカル消去能と総ポリフェノール量の変化を確認する。

## 4.貯蔵期間の影響

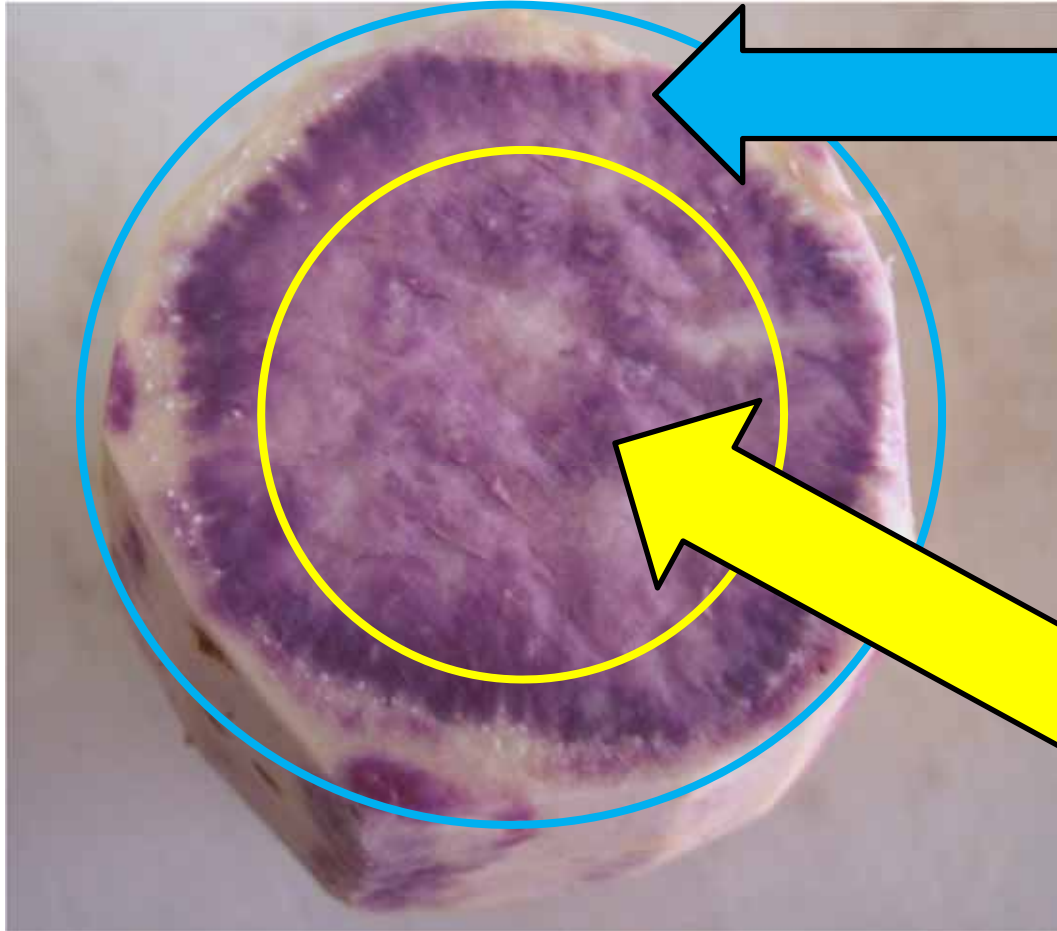
最適条件で電気処理を行い、**貯蔵時間**を24、48、72hと**変化**させ、DPPHラジカル消去能と総ポリフェノール量が**どのように変化**するか確認する。

# 実験方法

# 供試材料



市場で流通している2012年産「備瀬」を供試材料とした。



皮付近の果肉（以下皮付近）は外側から10mmの果肉を使用した。

中心の果肉（中心）は外側を取り除いた部分を使用した。



# 測定について

DPPHラジカル消去能→DPPH法



総ポリフェノール量→フォーリンチ  
オカルト法





# 実験結果

# 1.内観



未処理断面図



5 m A 断面図



1 0 m A 断面図



1 5 m A 断面図

変化なし



未処理断面図

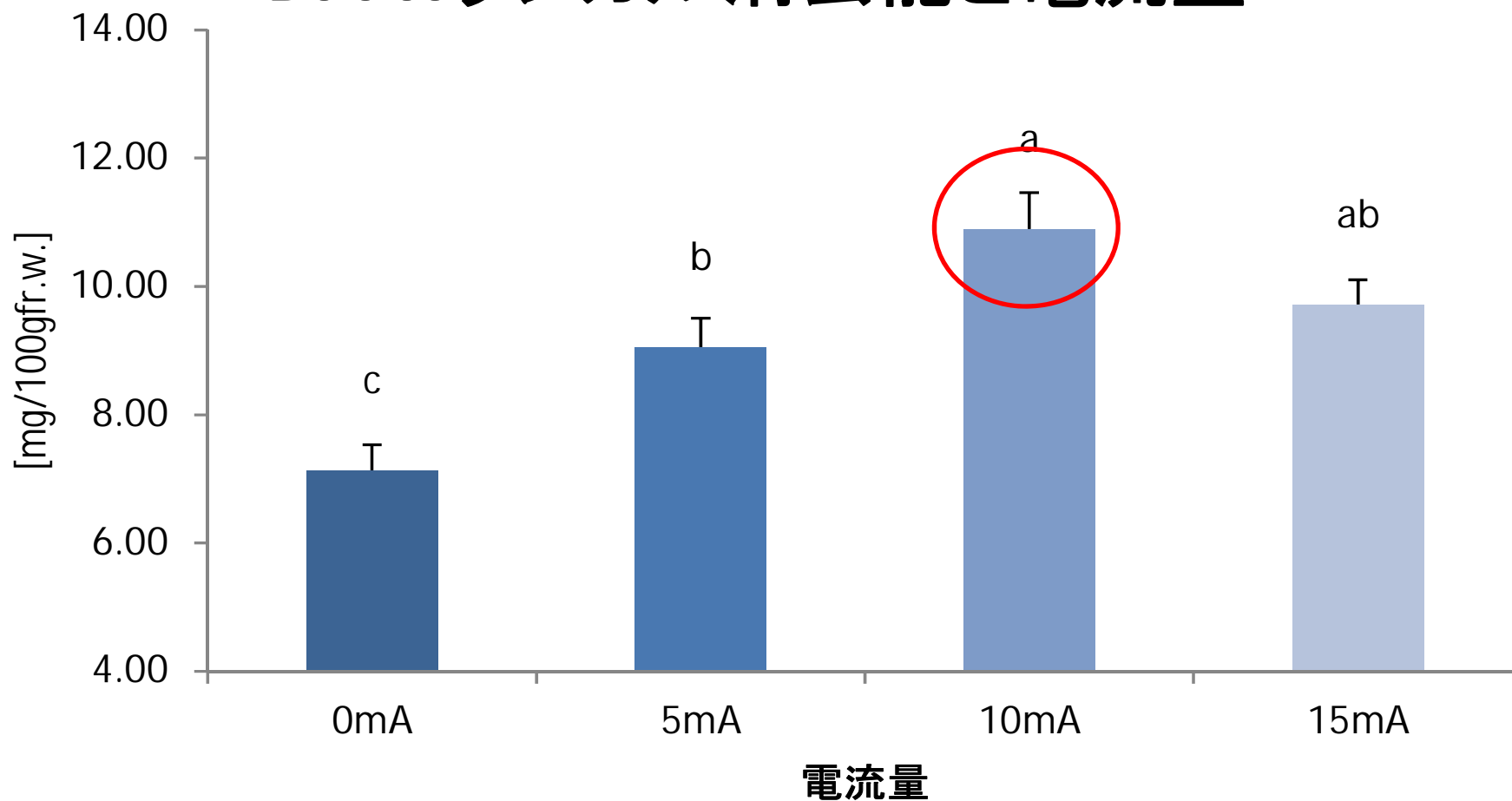


電気処理断面図

変化なし

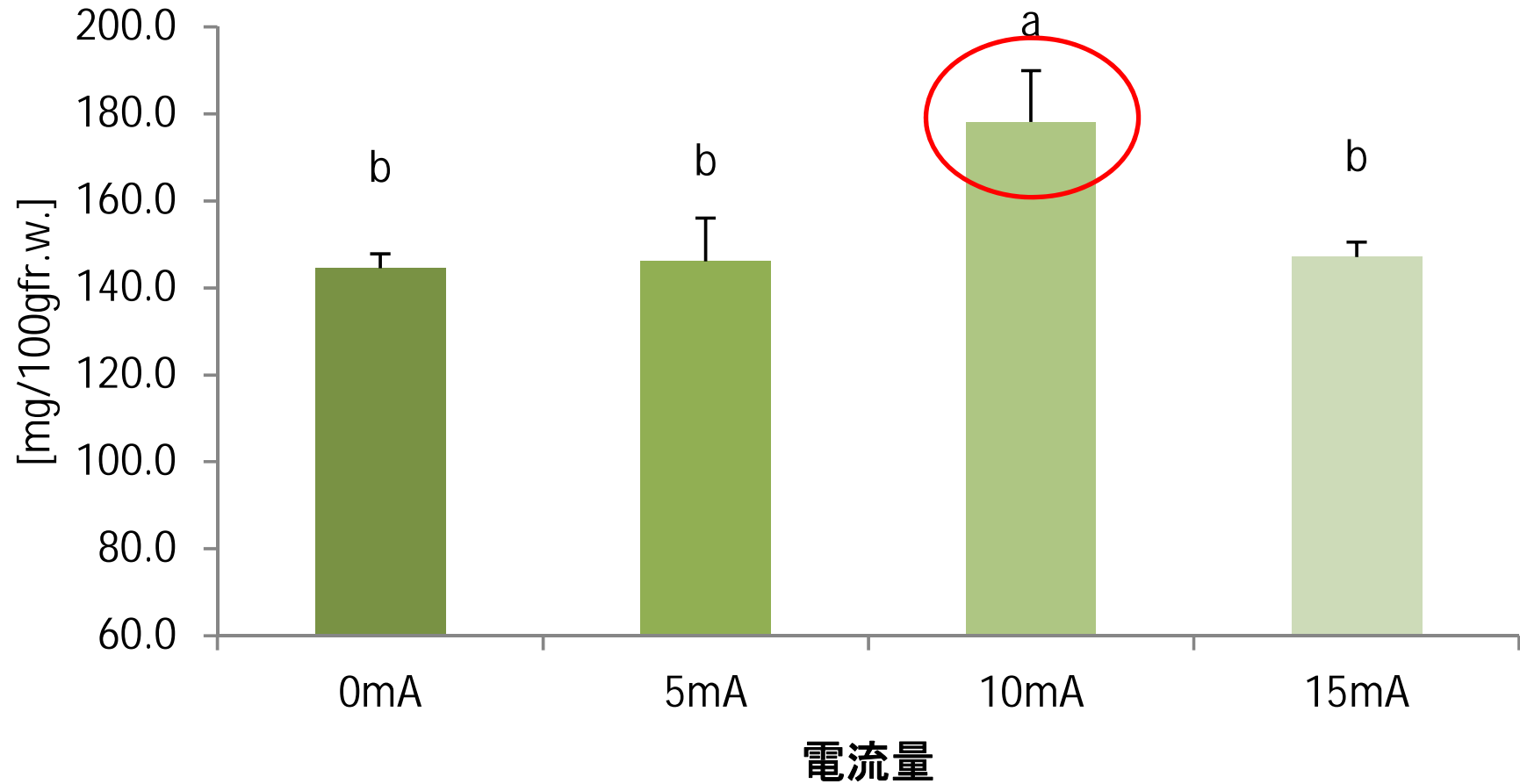
## 2 . 処理電流量と通電時間の影響

## DPPHラジカル消去能と電流量



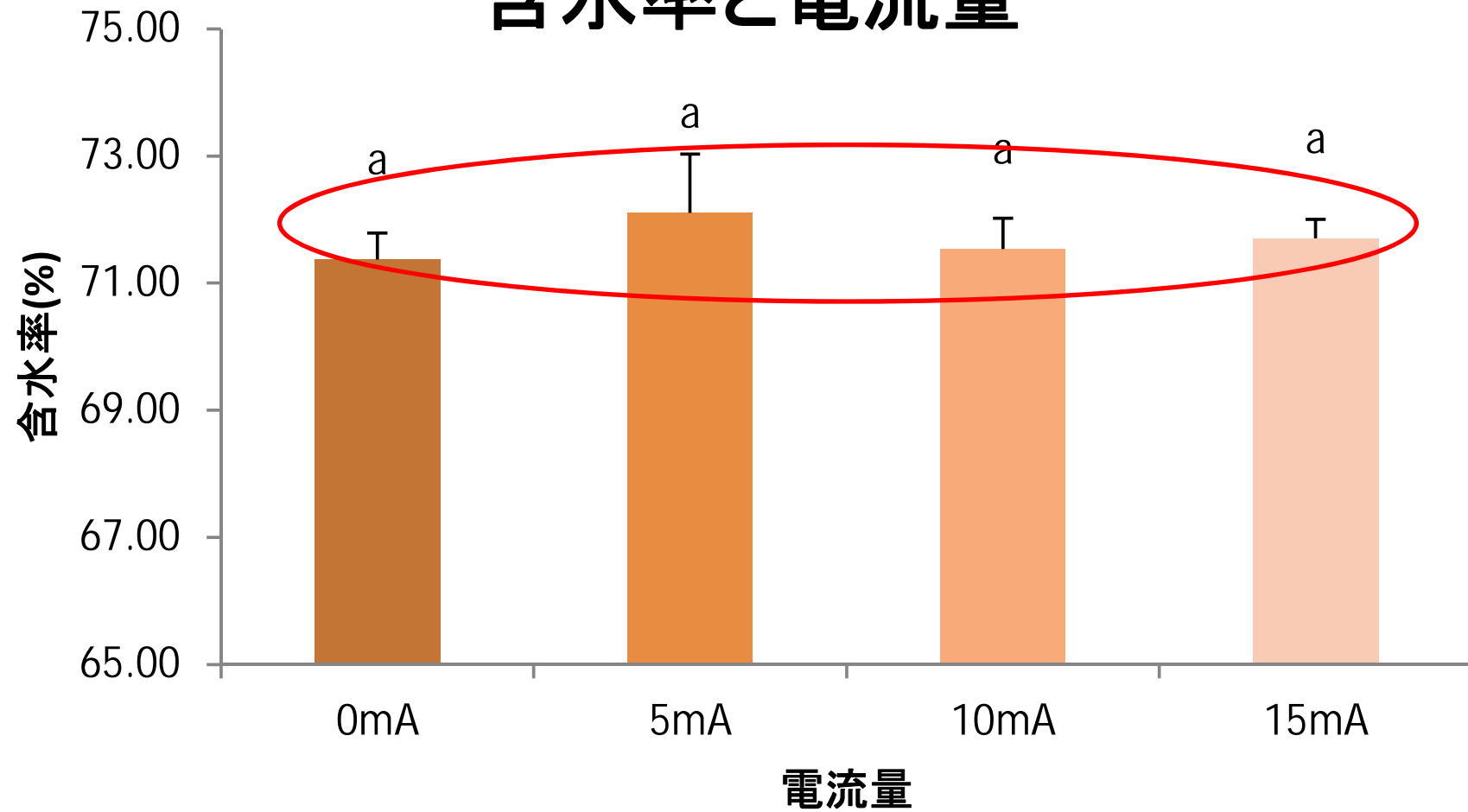
10mAで50%上昇

# 総ポリフェノール量と電流量



10mAで30%上昇

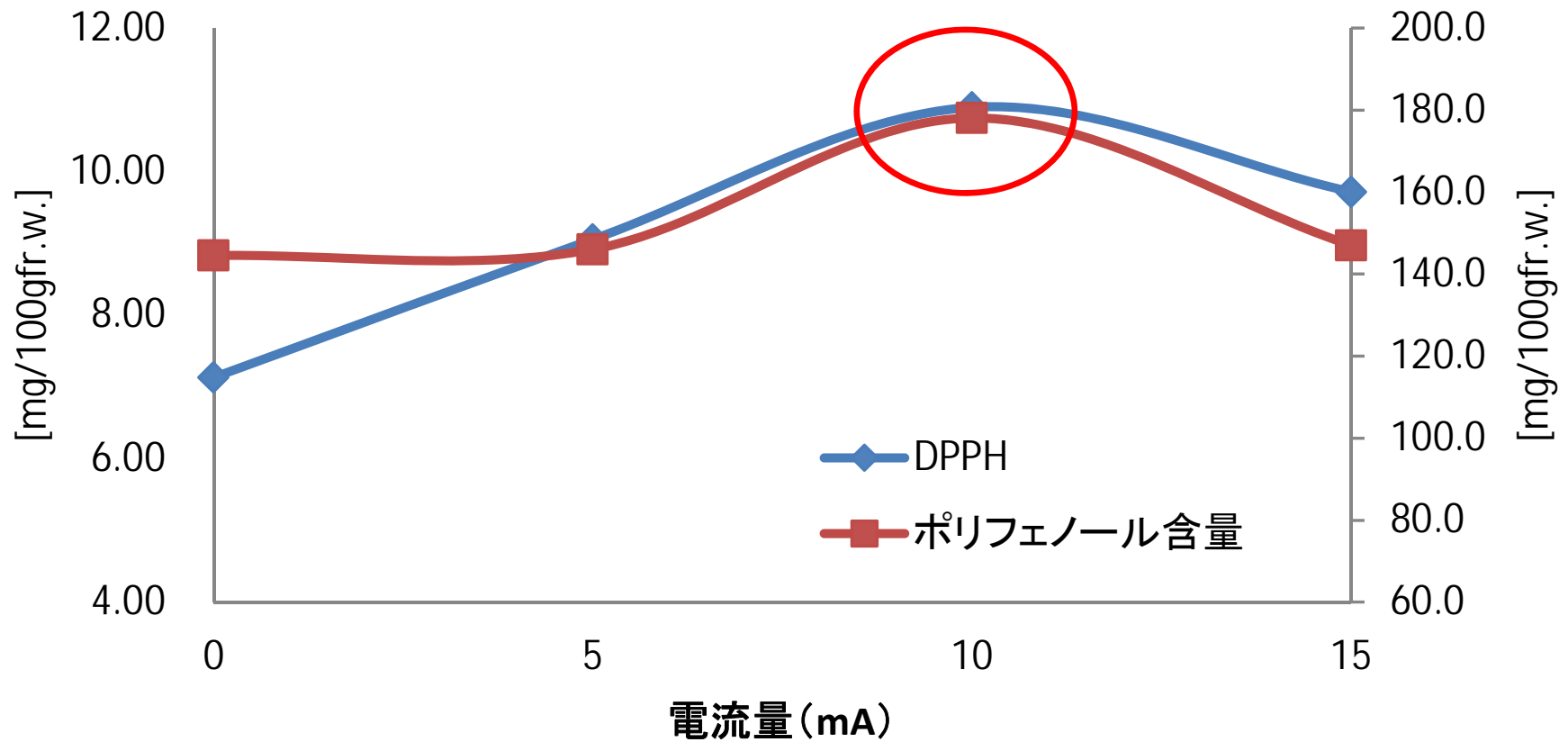
# 含水率と電流量



変化なし

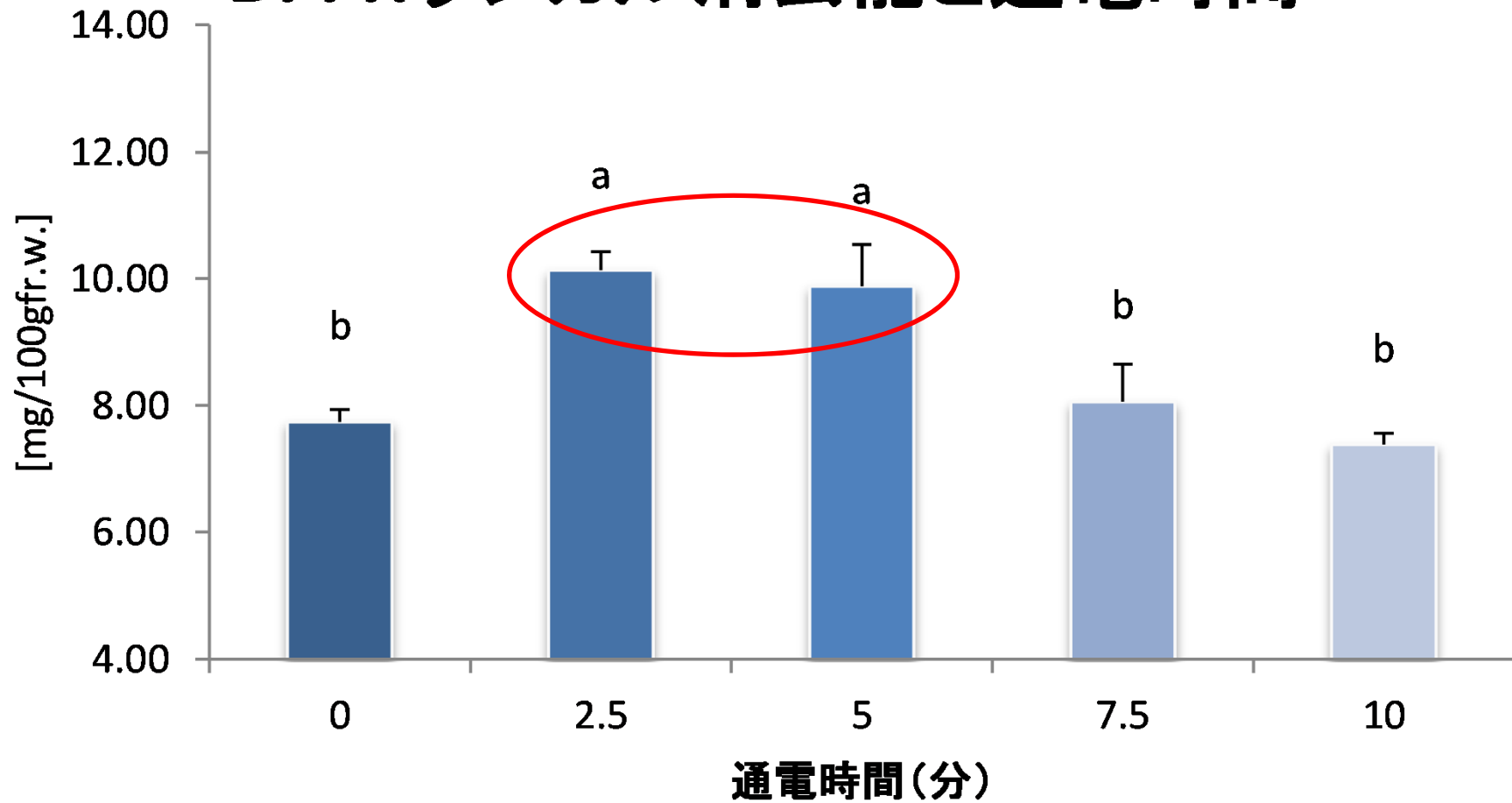


## 総ポリフェノール量とDPPHラジカル消去能の関係



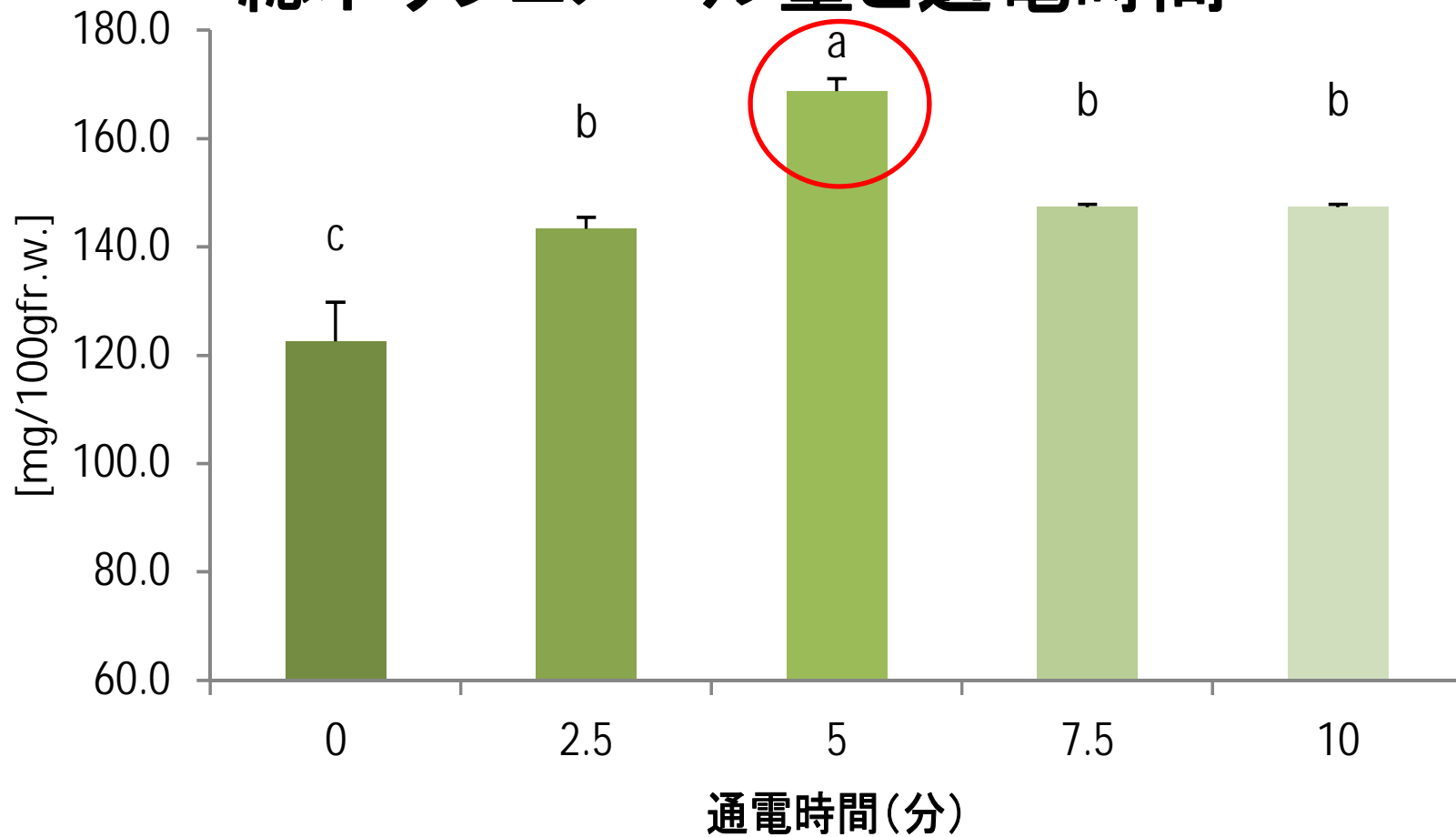
最適条件を 10 mA とした

# DPPHラジカル消去能と通電時間



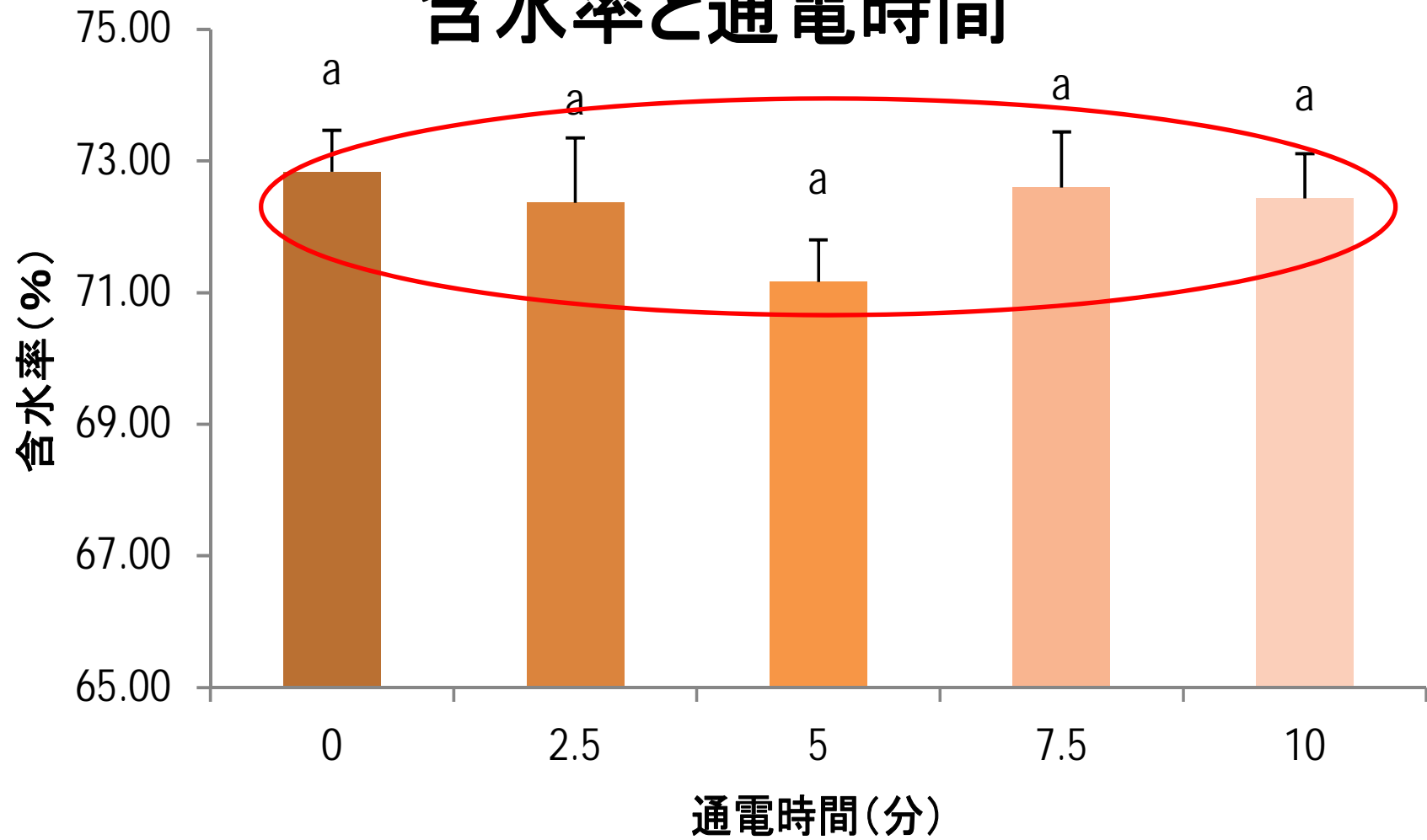
2.5、5分で30%上昇

# 総ポリフェノール量と通電時間



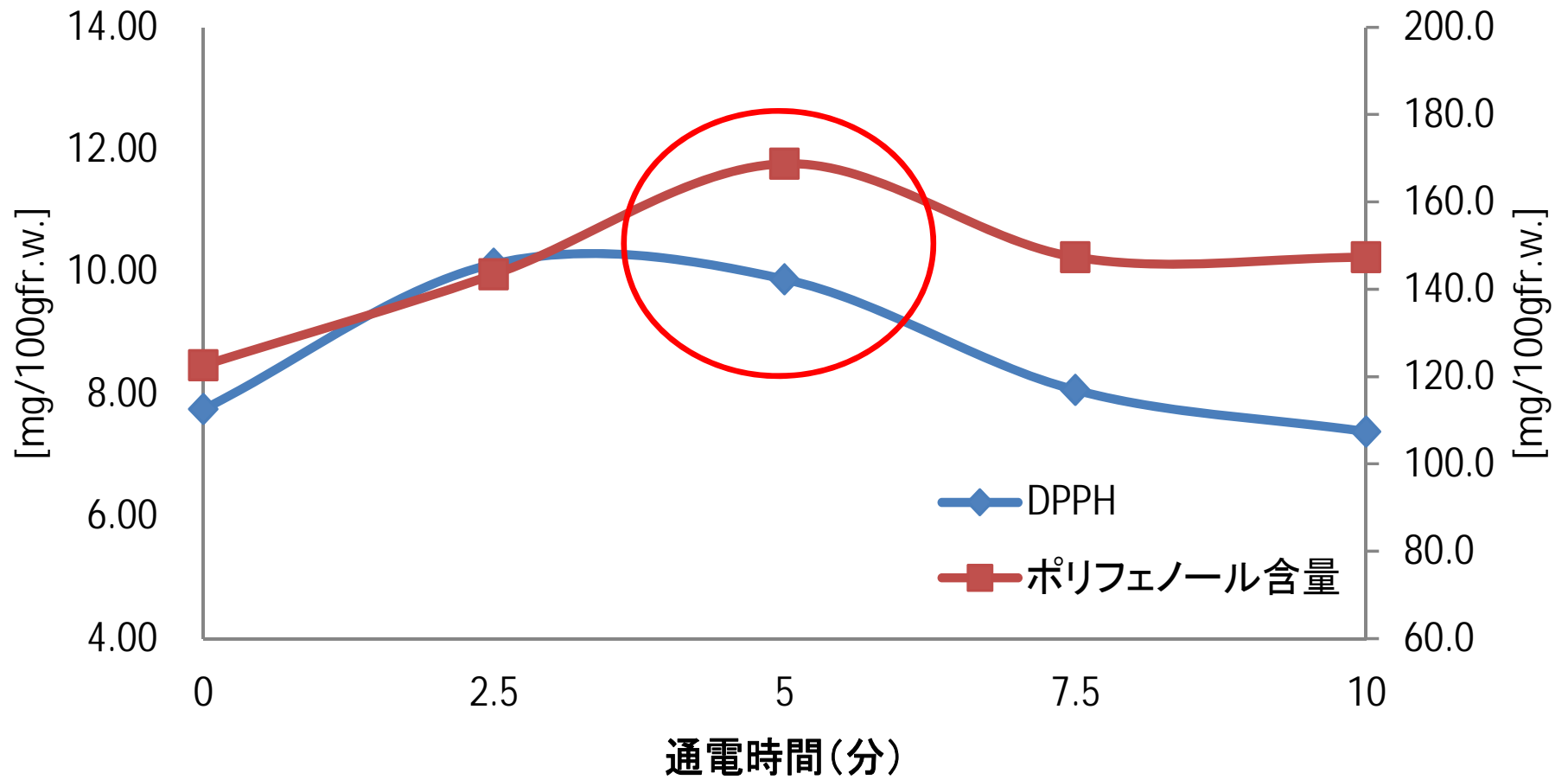
5分で30%上昇

# 含水率と通電時間



変化なし

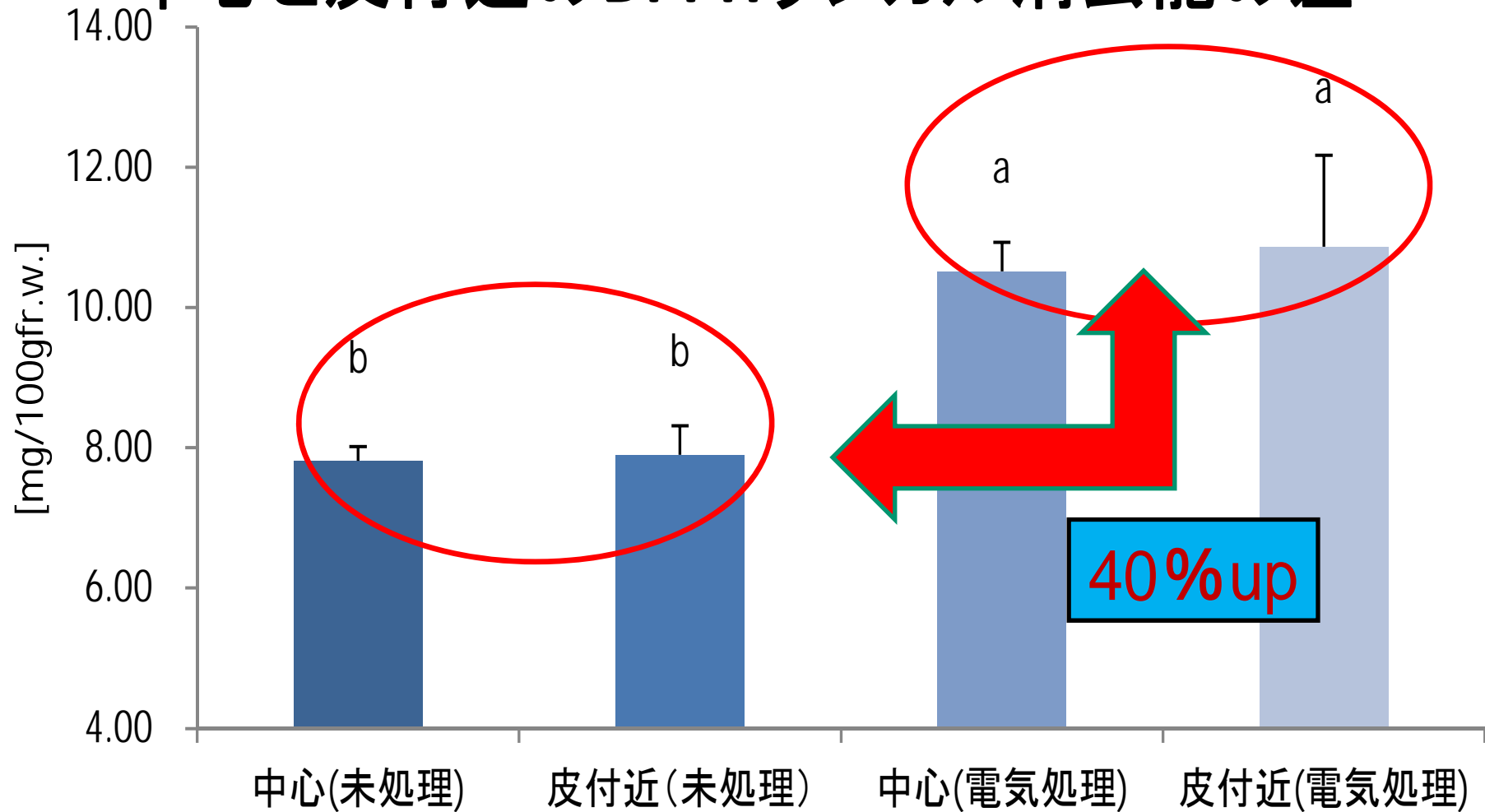
## 総ポリフェノール量とDPPHラジカル消去能の関係



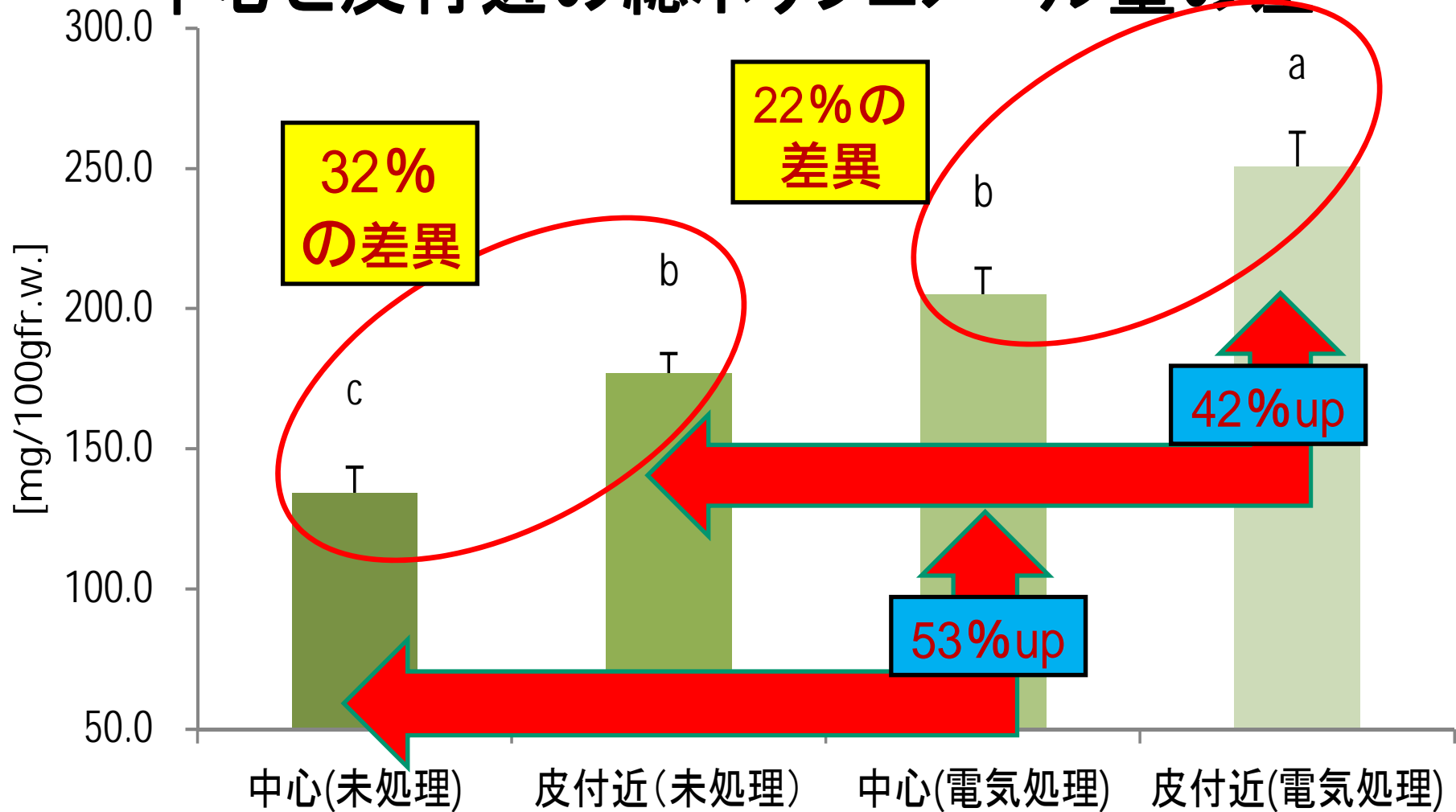
最適条件を5分とした

### 3 . 中心と皮付近の成分の差異

# 中心と皮付近のDPPHラジカル消去能の差



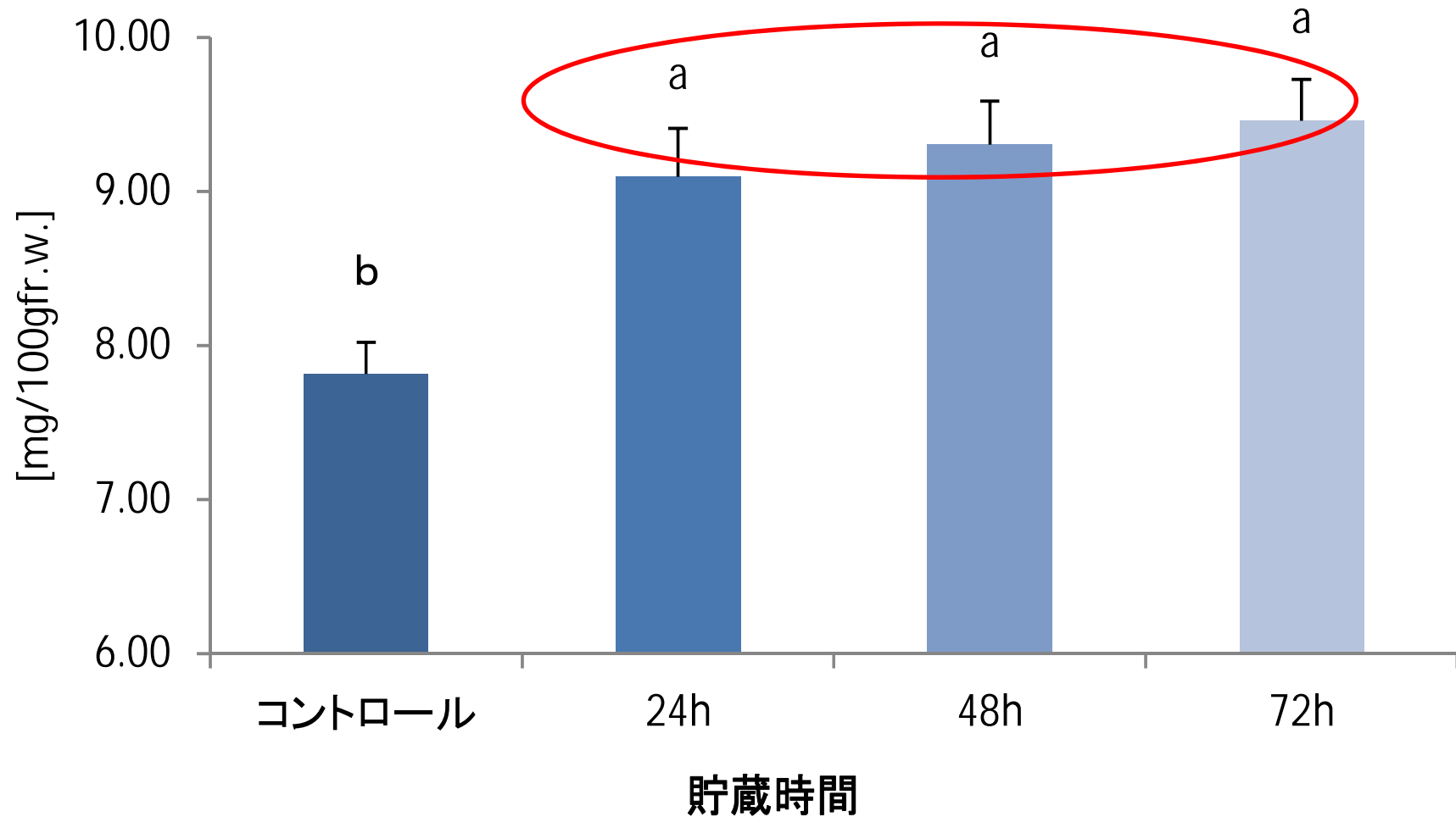
# 中心と皮付近の総ポリフェノール量の差





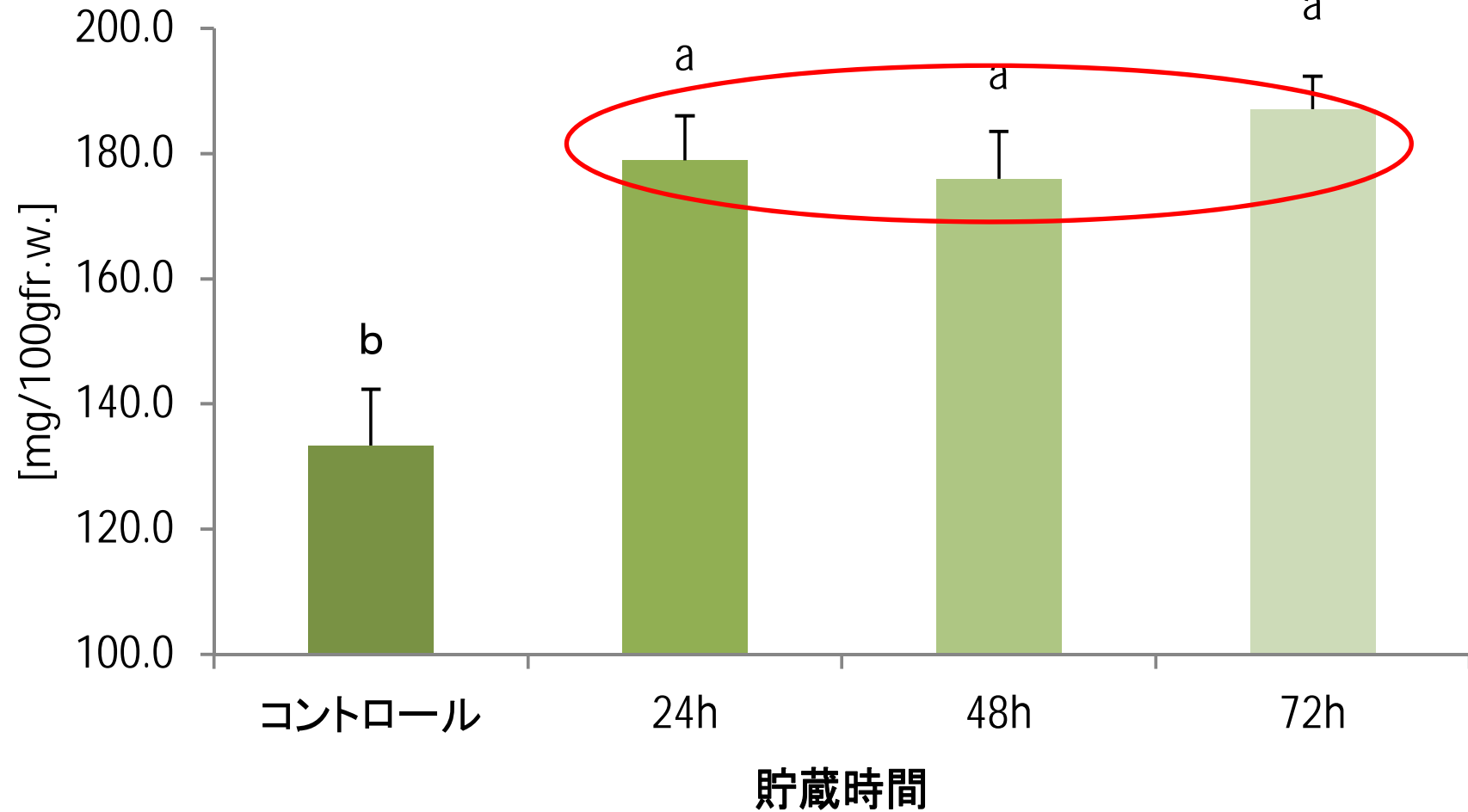
## 4 . 貯蔵時間の影響

# DPPHラジカル消去能と貯蔵時間



処理後72時間，維持される。

# 総ポリフェノール量と貯蔵時間



処理後72時間，維持される。

# まとめ

## 1.内観について

電気処理による色彩の**変化はなかった。**

## 2.電流量と通電時間の影響

1)電流量の**10mA**において、抗酸化活性およびポリフェノール含量は**最も増加**し、50および30%の上昇を示した。

2)通電時間では、**5分**で**最も**抗酸化活性およびポリフェノール含量は**増加**し、何れも30%の上昇を示した。

### 3. 中心の果肉と皮付近の成分の差異

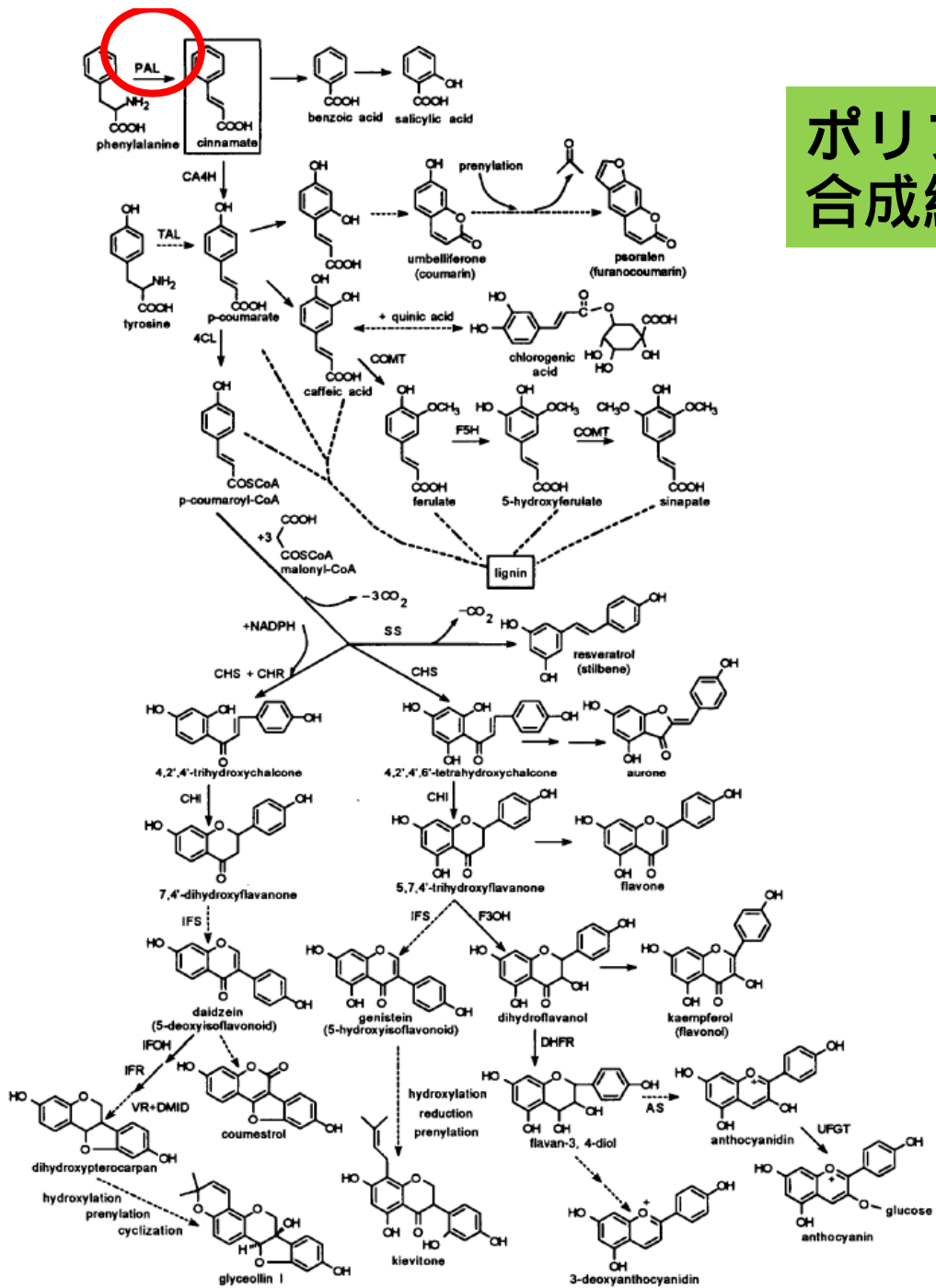
- 1) DPPHラジカル消去能は、未処理および電気処理ともに、中心と皮付近で差が見られなかった。
- 2) 総ポリフェノール含量は中心と皮付近に差が見られ、未処理および電気処理ともに、皮付近は中心よりも30%高かった。
- 3) 電気処理を行うと中心は1.5倍上昇し、皮付近は1.4倍上昇した。

### 4. 貯蔵期間の影響

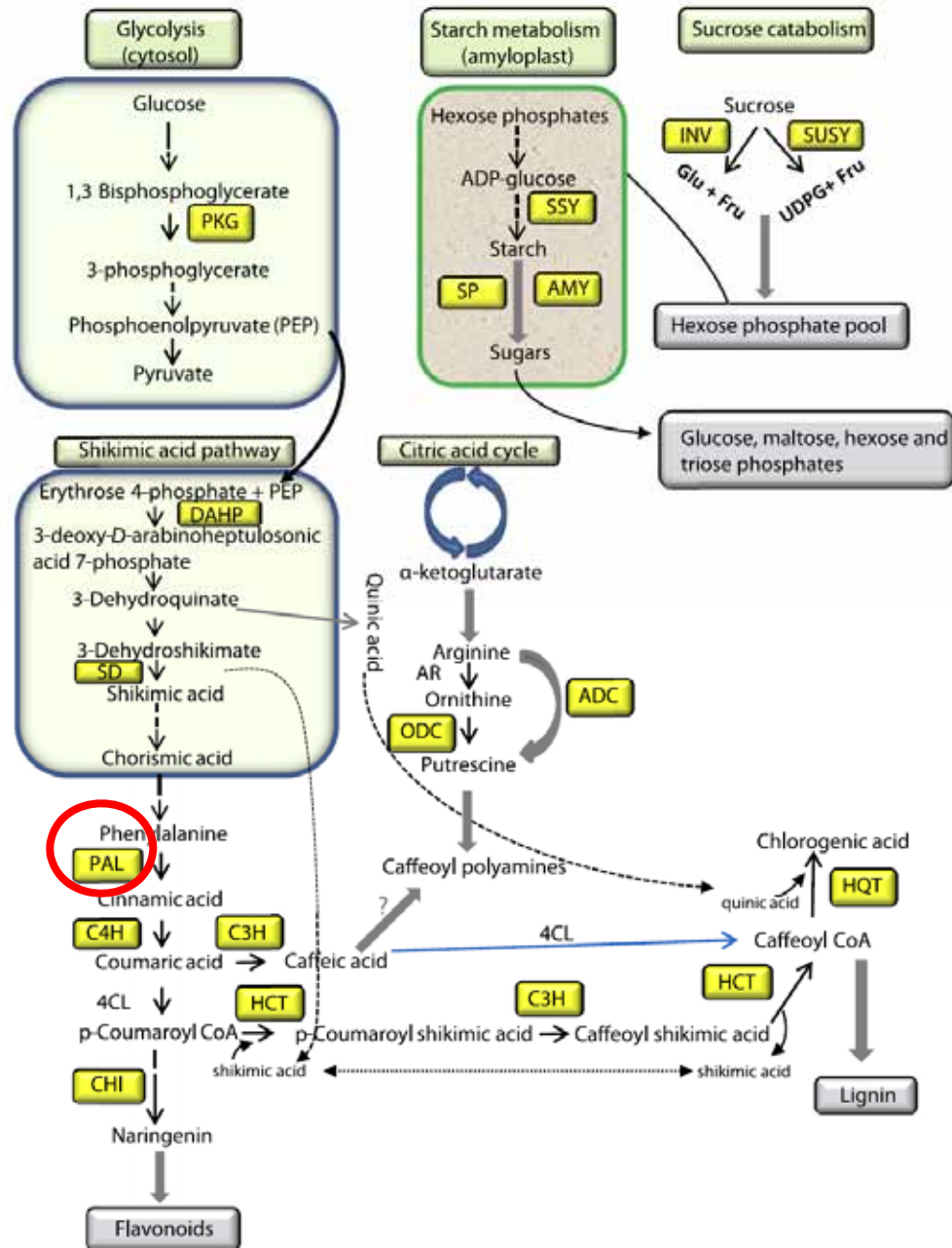
DPPHラジカル消去能および総ポリフェノール含量ともに、電気処理は処理後72時間まで高含量、高活性を維持した。

# 結論

1. 紅イモは電気処理に応答を示した。
2. 紅イモの最適電流量および処理時間は、10mA、5分であった。
3. 中心の果肉よりも皮付近の果肉に、ポリフェノールが多く含まれていることが分かった。
4. 紅イモにおいては、電気処理後72時間経過してもDPPHラジカル除去能および総ポリフェノール含量は減少しなかった。



# ポリフェノール合成経路





# 今後の課題

1. PAL(Phenylalanine ammonia lyase)活性の検討

2. 直流，交流の検討

3. アントシアニンの定量

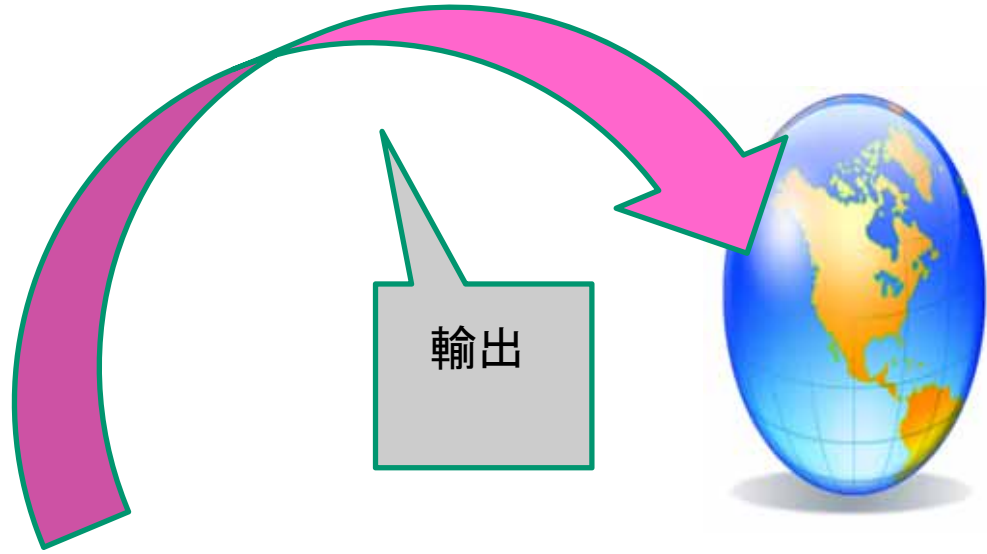
4. 各ポリフェノールの定量

5. 加熱特性

6. 他の農産物での挑戦



# <展望>



電気処理



高付加価値化



日本ブランド

輸出

# 沖縄産農産物の物理的処理による機能性強化





御静聴ありがとうございました。

