Correlation of Coumarin and Phenol Contents and Peroxidase Activity in Flours from Stored Cassava Roots with the Food Quality†

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The relationship between coumarin and phenol contents and peroxidase activity and the food quality of the flours made from stored cassava roots was investigated. The food quality was determined by sensory evaluation of the non-fermented “puto” (steamed bread) samples made from the flours of three kinds of chips which were prepared from the healthy tissues of the cassava roots that were stored for 0, 10 and 20 days, respectively. The results have confirmed that the storage of the roots allowed the tissues to produce increasing amounts of the secondary metabolites and higher activity of peroxidase. Further, the results of the study established that the contents of the secondary metabolites and the activity of peroxidase in the flours from the stored cassava roots had the inverse correlation with the food quality of the flours, that is, some sensory parameters, especially general acceptability of the “puto” samples made from such flours.

When cassava roots are harvested and stored in environmental conditions which are different from those in the soil where they grew, various cytological processes are activated in response to the injury caused by harvest and transport, and to the change in the environment. Among them, bluish fluorescent and phenolic components are produced mainly in the tissue where physiological deterioration appears, and in the non-infected tissue adjacent to the decaying tissue (microbial deterioration-showing tissue)1)3). The bluish fluorescent components were identified as scopoletin, esculin and scopolin, and a main phenolic component was proved to be (+)-catechin1)3). Further, it was demonstrated that these coumarin derivatives were produced in the tissue slices in response to cut-injury and drying until the tissue cells were killed by dehydration4). On the other hand, it was indicated that the occurrence of the secondary metabolism in cassava roots was severer when the storage period was longer5).

Since cassava roots deteriorate rapidly after harvest, it is essential to develop the methods of reducing loss due to deterioration leading to the expansion of the utilization of the roots. One of the approaches is to process them into dried chips which eventually are made into flour. Cassava flour is then utilized for making noodle6), cake, and “puto”, a fermented7) or non-fermented steamed bread.

In a previous paper8), it has been confirmed that the total amounts of the coumarins formed varied according to the methods of preparation of the flour. This was true also with peroxidase activity8). Further, it was suggested that cassava flour which did not contain the secondary metabolites such as coumarin derivatives was of fine quality as food material8).

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This paper aims at establishing that the grade of the secondary metabolism occurring in cassava roots differing in the storage period has the inverse correlation with the food quality of non-fermented “puto” samples made from the flours of such roots.

**Materials and Methods**

**Storage**

Roots of cassava (*Manihot esculenta* Crantz, cv. Laken, a sweet type, yellowish flesh) were harvested from the Institute of Plant Breeding, UPLB. Immediately after harvest the roots (about 30 kg) were cleaned of the soil and divided into three groups. The first group was washed immediately in running water, immersed in 0.5% NaOCl solution for 5 min for sterilization, and then washed thoroughly. Then, this group was dried without storage. This was designated as FL (fresh cv. Lakan sample). The second and third groups were placed inside jute bags and stored in a room (21 to 35°C and relative humidities of 72 to 97%) for 10 and 20 days, respectively, and designated as SL-10 (10 days-stored sample) and SL-20 (20 days-stored sample), correspondingly.

**Drying method**

After washing the roots thoroughly as mentioned above, the periderm and cortex were immediately removed, the roots cut transversely into slices 1 to 2 mm thick. Initially, the presence of fluorescence was investigated under a UV lamp (3650 Å), then the slices were dried in a cabinet drier equipped with an air blower at 50°C for 8 h. In the case of stored cassava samples (SL-10 and SL-20), the samples which showed advanced microbial deterioration were excluded. The dried chips were ground to 20-mesh flours using a coffee mill (National Model MK 54) for 30 sec per batch and the flours stored at room temperature prior to the analyses.

**Assays of coumarin and phenol contents and peroxidase activity**

Contents of coumarins and phenols were assayed by the previous methods with some modifications, and referred to as dry matter basis. Peroxidase activity was assayed by the method (α-phenylenediamine as the substrate) described in a previous paper. The activity was reported as the increase in A440 per min per a dry weight. The moisture content was assayed using an oven at 105°C.

**The method of making a non-fermented type of “puto”**

The three types of cassava flour from FL, SL-10 and SL-20 were used in making non-fermented “puto” samples. This type of a recipe is being used by the natives of the Camotes Islands, Cebu, Philippines. The flour was mixed thoroughly with water and placed in cans with holes at the sides and bottoms, and steamed for 45 min in a steamer (See Fig. 1).

**Sensory evaluation**

The “puto” samples made from the flours of FL, SL-10 and SL-20 were subjected to sensory evaluation. The judges consisted of 10 trained panelists. Each judge was given slices of each sample and was asked to score for color, odor, taste/flavor, texture/mouthfeel, sponginess, stickiness, and general acceptability, on a 7-point scale (+3 for like extremely and −3 for dislike extremely). The results were statistically analyzed by the scoring method of covariance analysis.
Results and Discussion

The fluorescence exhibited by the slices when examined under a UV lamp showed a marked intensity in the case of stored roots particularly in SL-20, although it was absent in the fresh sample (Table 1). The coumarin and phenol contents as well as peroxidase activity in the roots increased with prolonged days of storage as indicated previously\(^5\). The occurrence of the metabolite formation showed that there was an abrupt increase within the first 10 days and a subsequent gradual increase up to the 20th day. It has been demonstrated that the production of the coumarin and phenol components are induced preceding the appearance of postharvest deterioration, as indicated previously\(^1\)\(^5\).

At the end of the 10th day, some of the roots showed microbial deterioration. About 20% of the roots was discarded based on softening and fermented sour odor. The chips were made from the parenchymatous tissue of the remaining healthy roots of the second group. After the 20th day, almost 50% of the roots of the third groups was deteriorated by microbial attack and the tissues had fermented sour odor, and brown and softened texture. Since the remaining roots were still hard and healthy-looking, they were washed, peeled, and chipped. The flesh, however, became slightly off-white in color. The chips after drying were light brown and had perceptible odor.

Flours of FL, SL-10 and SL-20, and their “puto” samples are shown in Fig. 2. The texture did not show any difference among the

![Fig. 2 Flours of fresh and stored cassava roots and their “puto” samples](image)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
<th>(H_2O^+) %</th>
<th>Fluorescence(^a)</th>
<th>Coumarins (\mu g/g) dry wt.</th>
<th>Phenols (\mu g/g) dry wt.</th>
<th>Peroxidase (A_{440}/\text{min/g dry wt.})</th>
</tr>
</thead>
<tbody>
<tr>
<td>FL</td>
<td>Fresh harvested, chipped immediately after harvest, 1~2 mm thick, dried 50°C, 8 h at cabinet drier</td>
<td>14.0</td>
<td>—</td>
<td>4.4</td>
<td>2.2</td>
<td>9.3</td>
</tr>
<tr>
<td>SL-10</td>
<td>Stored for 10 days, chipped 1~2 mm thick, dried 50°C, 8 h at cabinet drier</td>
<td>10.6</td>
<td>5+</td>
<td>59.2</td>
<td>13.2</td>
<td>64.0</td>
</tr>
<tr>
<td>SL-20</td>
<td>Stored for 20 days, chipped 1~2 mm thick, dried 50°C, 8 h at cabinet drier</td>
<td>8.7</td>
<td>10+</td>
<td>73.5</td>
<td>28.4</td>
<td>86.8</td>
</tr>
</tbody>
</table>

\(\text{Table 1 The effect of storage on the coumarin and phenol contents and peroxidase activity in cassava roots}\)

\(^a\) assayed by drying the samples in an oven at 105°C

\(^a\) means no fluorescence; 10+, highest
"puto" samples as far as observed, and the color was slightly yellow in the sample from FL, and turned brown in the cases of stored cassava samples; the intensity was higher in the sample from SL-20 than from SL-10. As shown in Fig. 3, the results of the sensory evaluation indicated that any two of the three samples differed significantly in color, odor, taste/flavor, texture/mouthfeel, sponginess, stickiness and general acceptability at the 5% level of significance, except for color between FL and SL-10. The sample from FL had the highest score in terms of general acceptability, while the sample from SL-20 was consistently scored at the lowest level in all the sensory parameters particularly in odor and taste/flavor. Thus, the above results indicated that the grade of the secondary metabolism occurring in cassava roots differing in the storage period had the inverse correlation with some sensory parameters, especially general acceptability on the food quality of non-fermented "puto" samples made from the flours of such roots.

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References


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貯蔵キャッサバ塊根フラワー中のクマリン、フェノール含量及びペルオキシダーゼ活性とその食品品質との相関性

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貯蔵キャッサバ塊根フラワー中のクマリン、フェノール含量及びペルオキシダーゼ活性とその食品品質との関係が調査された。その食品品質については、収穫直後の、又10日間及び20日間貯蔵されたキャッサバ塊根の健全組織から調製されたフラワーから非発酵性のフト（"puto"，一種の蒸しパン）を製造し、その官能評価にによって決めることとした。先ず塊根の貯蔵が長引くとそれだけ二次代謝産物含量及びペルオキシダーゼ活性が高まることを確認した。更に、貯蔵塊根フラワー中のこれらの増加は、これらのフラワーから製造されたプト製品の品質に関する数種官能要因、特に絶対評価と逆の相関にあることを明らかにした。

Control of Food Quality and Food Analysis

BIRCH, G. G. and PARKER, K. J. 編

1983年の3月22日～24日、英国、リーディング大学で開催されたInternational Industry-University symposiumの第14年会での発表をまとめた成書である。全18章からなり、1章から11章までは品質管理と食品分析、栄養素成分の評価、食品成分と分析精度、免疫法、微生物物質、官能評価など一般問題を扱い、12～18章では、ジャガイモの貯蔵と品質、乳製品や畜肉の品質、缶詰工程の温度管理、果実と野菜の加工による品質変化の問題などの各論の内容を収載している。著者はいずれもその分野の専門家であまり、今日の現状から問題を捉えてまとめている。

9.6インチ、332頁、35ポンド、

Developments in Food Colours-2

John Walford 編者

先に発行されたVolume Iの続編で、その後の食用色素の利用に関する各国の行政措置、合成色素の分析法、色調と官能的評価、天然色素の利用、食品添加物と色素の反応等における新しい展開や研究成果についてそれぞれ7編に分けて総論的に記載されている。食用色素の分析法については、最近発達の著しい高度液体クロマトグラフィーによる手法を紹介されており、関連成分の文献も豊富に引用されている。色調と官能的評価については食品色調と選択の問題や品質指標としての色調の役割、色調の臭気の発現などが取り上げられている。最も関心の寄せられる天然色素については、約190件の文献を引用して解説が加えられている。食品添加物、食品色素など食品行政にたずさわる者、食品製造者などには参考になる場面が多いと考えられる。

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