DEVELOPMENT OF BEVERAGE PRODUCTS FROM YACON
(Smallanthus sonchifolius)

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ABSTRACT

Yacon (Smallanthus sonchifolius) has been cultivated in the Philippines since 1995 and has attracted health-conscious consumers because it was identified as the plant source with the largest content of Fructooligosaccharides (FOS). FOS in yacon is a type of sugar that has a lower caloric value than other sugar types (approximately 25 to 35% of the calories of normal carbohydrates). Yacon FOS is completely fermented in the colon by probiotics, a group of beneficial bacteria that forms part of the intestinal micro flora. These contribute to better gastrointestinal function and help to alleviate several digestive disorders. It is also recognized as soluble fiber which causes several favorable effects during digestion. It may also enhance mineral absorption. However, yacon tubers are perishable and nutritional content as well as FOS significantly decrease during post-harvest storage. Development of value-added products is necessary to reduce storage time, increase utilization of this root crop and reduce economic losses due to spoilage. The objective of the study are to develop beverage products from yacon, characterize the products in terms of their chemical composition, physico-chemical, microbiological and sensory properties, and shelf-life. A ready-to-drink (RTD) juice from the tubers and tea from the leaves were developed. Moisture, ash, energy, total fat, protein, sodium, potassium, and titratable acidity were determined using AOAC methods. Total soluble solids (TSS), pH and color of the beverage products were measured. Aerobic plate count, mold and yeast count, E. coli, Salmonella sp and, Staphylococcus aureus were quantified using US FDA-BAM Methods. Sensory evaluation using the 9-point hedonic scale was conducted to determine the acceptability of the beverage products. The total phenols and antioxidant activity based on lipid peroxidation of the RTD juice and tea were determined using spectrophotometric methods while FOS content of the RTD juice drink was quantified using a validated HPLC method. Yacon juice. The juice is clear and light brown in color. RTD yacon juice per 100 gram sample contains: 87 g moisture, 12 g total carbohydrates, 0.2 g protein, 0.5 g ash, 50 kcal energy, 30 mg sodium, and 127 mg potassium. It has higher potassium content than pineapple fruit, and provides similar energy as strawberry fruit juice drink. Its total soluble solids measure 12.50 Brix, titratable acidity is 0.4% and pH...
is 3.7, similar to those of sugar cane juice. Total phenols of 39 mg/100g, contributes to the antioxidant activity measured at 55.3%. It is classified as an intermediate glycemic index food with GI of 61 +2. Potassium to sodium ratio is 4:1; a potassium intake of two to four times the sodium intake favors lower blood pressure. Microbiological analysis showed that the juice is within safe limits set by the Philippine Food and Drug Administration (FDA). Sensory evaluation showed that the juice is acceptable; it received a general acceptability score of 7.0 to 7.7 equivalent to “like moderately” to “like very much”. Total fructooligosaccharides content is 506 mg per 250 mL bottle. Consumption of 2 bottles of RTD juice would mean significant intake of FOS when compared to the average daily consumption of FOS in the US, estimated to be 1-4 grams. The juice is shelf-stable for 5 months when stored at room temperature. Yacon tea RTD yacon tea is a low-calorie, zero fat drink with total soluble solids of 9.40 Brix and pH of 7.3. The total antioxidant activity is recorded at 53.8%, and with total phenols of 38 mg/100g. Microbiological analysis showed that the tea is within safe limits set by the FDA. It received general acceptability score of 7.2 to 7.5 equivalent to “like moderately” to “like very much”. Packed in 500 mL PET bottles, yacon tea is shelf-stable for 2 months. Yacon tubers and leaves can be processed into high-value products such as juice and tea. Both products are low-calorie, ready-to-drink beverages, with antioxidants. RTD juice from yacon tubers is a significant source of fructooligosaccharides which is known to promote better health of the intestinal tract. Pilot scale production of the developed products is recommended to determine technical and economic feasibility for commercial production. For longer shelf-life, process improvement and the use of other packaging materials should be studied for yacon tea.

INTRODUCTION

- Yacon is grown in four provinces in the Philippines and sold in their local markets. It is also available in wet markets and leading supermarkets in Metro Manila.

- Yacon tuber has a unique carbohydrate composition wherein it stores carbohydrates as fructooligosaccharide (FOS), a dietary sugar which the human body can not metabolize making it a potential ingredient for controlling diabetes and body weight. Oligofructose was also found to be associated with improved
gut health because of the stimulation of bifidus bacteria in the colon.

- Yacon leaves has significant amount of antioxidant and phenolic compounds.
- Yacon tubers and leaves are highly perishable and nutritional content and FOS of tubers decrease significantly during post harvest storage.
- Processing yacon tubers and leaves into value added products will prolong the shelf-life and increase marketability.
- Commercial production of the developed products will provide economic benefits to yacon growers and farmers.
- The general objective of the study is to develop beverages utilizing yacon tubers and leaves.
- The specific objectives are (1) to develop a juice product from yacon tubers and a tea drink from yacon leaves; (2) to standardize the formulation and process for the production of juice and tea drink from yacon; (3) to evaluate the chemical, physico-chemical, microbiological and sensory properties of the developed products; and (4) to conduct shelf life estimation of the products developed.
MATERIALS AND METHODS

Development of product concept
(Focus group discussion)

Trial formulation

Optimization of formulation

RTD yacon juice
Selection and preparation of raw materials
Extraction
Concentration
Bottling and sterilization
Pasteurization
Sealing and labeling

RTD yacon tea
Selection and preparation of raw materials
Brewing
Mixing with other ingredients
Pasteurization
Bottling and cooling
Sealing and labeling

Characterization of optimized products
(Sensory evaluation, chemical, physico-chemical, and microbial analysis)

Shelf-life study
(Sensory evaluation, chemical, physico-chemical, and microbial analysis)
RESULTS

Chemical analysis of RTD yacon juice

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Composition (per 100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture, g</td>
<td>86.9</td>
</tr>
<tr>
<td>Ash, g</td>
<td>0.5</td>
</tr>
<tr>
<td>Energy, kcal</td>
<td>50.0</td>
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<tr>
<td>Total Fat, g</td>
<td>0.0</td>
</tr>
<tr>
<td>Protein, g</td>
<td>0.2</td>
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<tr>
<td>Total Carbohydrates, g</td>
<td>12.4</td>
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<tr>
<td>Sodium, mg</td>
<td>30.0</td>
</tr>
<tr>
<td>Calcium, mg</td>
<td>3.4</td>
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<tr>
<td>Potassium, mg</td>
<td>126.5</td>
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</table>

Physico-chemical analysis of RTD yacon juice

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
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<tbody>
<tr>
<td>Moisture</td>
<td>88.20%</td>
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<tr>
<td>% Total solids</td>
<td>11.80%</td>
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<tr>
<td>pH</td>
<td>3.7</td>
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<tr>
<td>Total soluble solids</td>
<td>12.5 Brix</td>
</tr>
<tr>
<td>Color (Munsell)</td>
<td>10Y8/4</td>
</tr>
<tr>
<td>Color (Minolta chromameter)</td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>13.9</td>
</tr>
<tr>
<td>a*</td>
<td>+0.5</td>
</tr>
<tr>
<td>b*</td>
<td>+2.8</td>
</tr>
<tr>
<td>Titratable acidity</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Microbiological analysis of RTD yacon juice

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Aerobic Plate Count</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Mold and Yeast Count</td>
<td>&lt;0.3</td>
</tr>
<tr>
<td>Coliform Count, MPN/ml</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
Graphical representation of the sensory evaluation of RTD yacon juice

Functional properties of RTD yacon juice

Antioxidant activity,

1. % Lipid peroxidation 55.29
2. Total phenols, mg/100g 38.93
3. Glycemic index 61.2
4. Potassium to sodium ratio 4

Fructooligosaccharides (per 250ml)
GF2 (Kestose) 230.64mg
GF3 (Nystose) 161.71mg
GF4 (Fructofuranosyl nystose) 114.25mg
5. Total FOS 506.60mg

Chemical analysis of RTD yacon tea
Parameters | Composition (per 100g)  
--- | ---  
Moisture, g | 90.8  
Ash, g | 0.0  
Energy, kcal | 37.0  
Total Fat, g | 0.0  
Protein, g | 0.0  
Total Carbohydrates, g | 9.2  
Total sugar, g | 8.7  

**Physico-chemical analysis of RTD yacon tea**

- Moisture: 90.10%  
- % Total solids: 9.90%  
- pH: 7.3  
- Total soluble solids: 9.4 Brix  
- Color (Munsell): 7.5Y6/2  
  - Color (Minolta chromameter):  
    - L*: 16.39  
    - a*: +2.35  
    - b*: -3.13  
- Titratable acidity: 0.0  

**Microbiological analysis of RTD yacon tea**

- Aerobic Plate Count: <1  
- Mold and Yeast Count: <1  
- E. Coli Count, MPN/ml: <0.3  
- Salmonella sp., per 25ml: Negative  
- Staphylococcus aureus, CPU/ml: <1  

![9 Point Hedonic Scale](image.png)
Graphical representation of the sensory evaluation of RTD yacon tea

Functional properties of RTD yacon juice

- Antioxidant activity,
  1 % Lipid peroxidation 53.79
  2 Total phenols, mg/100g 37.97

1 - refers to the oxidative degradation of lipids whereby free radicals "steal" electrons in cell membranes, resulting in cell damage. The antioxidant activity in yacon juice and tea shows that % lipid peroxidation was reduced by 45 to 47%
2 - may bolster cellular antioxidant defenses; may contribute to maintenance of healthy vision and heart health
3 - Considered as intermediate glycemic index food
4 - Potassium to sodium ratio - diet high in potassium and low in sodium favors lower blood pressure. A potassium intake of two to four times the sodium intake or a sodium-potassium ratio of 0.25-0.50 has been suggested as the optimal range.
5 - FOS - may improve gastrointestinal health and enhance mineral absorption

CONCLUSION AND RECOMMENDATION

- Yacon tubers and leaves can be processed into high value products such as juice and tea. Yacon juice is an all natural, no preservatives and no sugar added juice drink with a significant amount of fructooligosaccharide. Yacon tea is a low-calorie beverage with antioxidants.

- Concerns about the rise in the incidence of lifestyle and diet related diseases have led to consumers’ increasing demand for healthier food or food ingredients
and has stimulated the development of food products with functional properties.

- Pilot scale production of the developed products is recommended to determine technical and economic feasibility for commercial production.

- The efficacy of the yacon juice for the improvement of gastrointestinal health is also recommended to be studied.