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SHORT COMMUNICATION

# Nutritional and taste characteristics of low-potassium lettuce developed for patients with chronic kidney diseases



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## KEYWORDS

hyperkalemia;  
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sensory evaluation

**Summary** Dietary potassium restriction is recommended for chronic kidney disease (CKD) patients with hyperkalemia. Boiling or soaking vegetables in water is known to decrease their potassium content. However, these methods can also reduce the quantity of other nutrients. Recently, low-potassium (LK) lettuce has been developed for CKD patients with hyperkalemia. This study compared the potassium content, other nutritional values, and taste characteristics of LK lettuce with those of normal lettuce. The amounts of potassium and other nutrients in LK lettuce, normal leaf lettuce, and normal leaf lettuce that had been soaked in water were measured and compared. The taste characteristics of LK lettuce and normal leaf lettuce were evaluated for saltiness, bitterness, and overall preference. The LK lettuce contained a lower amount of potassium (−87%) than the normal leaf lettuce. There was no difference in the other nutritional contents between LK lettuce and normal leaf lettuce, except for higher sodium and lower nitrate contents in LK lettuce. Taste evaluation revealed that the LK lettuce had lower bitterness and higher saltiness than the normal leaf lettuce. The overall preference score was significantly higher for LK lettuce. The potassium content of LK lettuce was significantly lower than that of normal leaf lettuce, but the other nutritional values were very similar. The LK lettuce had a higher preference score than the normal leaf lettuce. These results indicate that the LK lettuce is useful for increasing the variety of foods in CKD patients with hyperkalemia.

**背景：**對於血鉀過高的慢性腎病 (CKD) 患者，建議限制飲食中的鉀。用水浸泡或煮食則會降低蔬菜中的鉀含量，然而亦會同時降低其他營養素含量。最近，有專家特別為血鉀過高的 CKD 患者研發出低鉀萵苣。本研究對低鉀萵苣的鉀含量、營養與味道特徵作出調查，並與正常的萵苣作出比較。

**方法：**研究人員分別對低鉀萵苣、正常葉萵苣、與泡水後的正常葉萵苣，測量了鉀及其他營養素含量。對於低鉀萵苣及正常葉萵苣的味道特徵，則根據鹹度、苦澀度、及整體偏好作出評估。

**結果：**低鉀萵苣的鉀含量比正常葉萵苣低 87%，其他營養素方面，與正常葉萵苣相比，低鉀萵苣

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具較高的鈉及較低的硝酸鹽含量。味道評估顯示，相比於正常葉萵苣，低鉀萵苣的苦澀度較低，鹹度則較高。整體偏好上，低鉀萵苣的得分高於正常葉萵苣。

結論：與正常葉萵苣相比，低鉀萵苣的鉀含量較低，但其他營養素含量相似。同時，低鉀萵苣的整體味道偏好比正常葉萵苣較佳。本研究的結果顯示，對於血鉀過高的慢性腎病患者，低鉀萵苣是適合的食物選擇之一。

## Introduction

Hyperkalemia is a common life-threatening complication in patients with chronic kidney disease (CKD).<sup>1</sup> Severe hyperkalemia can induce cardiac arrhythmias and cardiac arrest causing sudden death.<sup>2</sup> Therefore, CKD patients with hyperkalemia are recommended to limit potassium intake to <1500 mg/day (Stage 5 patients) or 2000–2500 mg/day (Stage 3 and Stage 4 patients).<sup>3</sup>

Common potassium-rich foods are vegetables, fruits, potatoes, beans, and grains. Because potassium dissolves easily in water, CKD patients with hyperkalemia are educated to cut these potassium-rich foods into small pieces and boil or soak them in a large volume of water prior to eating. However, a substantial proportion of the potassium in potassium-rich foods remains even after these food-preparation procedures.<sup>4,5</sup> Furthermore, these food-preparation methods might result in the loss of other nutrients such as water-soluble vitamins and minerals and in a loss of desirable texture of the raw lettuce.<sup>4</sup>

Recently, some low-potassium (LK) crops (spinach and melon) have been developed in Japan.<sup>6,7</sup> They are grown using the following method: First, the seeds are selected and grown in normal liquid fertilizer. After 4 weeks, the fertilizer is replaced by a nonpotassium liquid fertilizer, with KNO<sub>3</sub> being substituted by HNO<sub>3</sub>. Using this method it is possible to reduce the potassium content of crops without inhibiting their growth. Recently, this cultivation method was applied to develop an LK leaf lettuce by Aizufujikako Co., Ltd. (Tokyo, Japan). In this study, we compared the potassium content as well as other nutrient values and taste characteristics of LK lettuce with normal leaf lettuce, and evaluated its usefulness for CKD patients with hyperkalemia.

## Materials and methods

### Measurement of potassium

The LK lettuce was provided by Aizufujikako Co., Ltd. The type of normal leaf lettuce used is commonly called *Frillice*, which is the same kind of leafy-type lettuce cultivar as LK lettuce, and was purchased from local markets. The potassium content of fresh LK lettuce, normal leaf lettuce, and normal leaf lettuce that had been soaked in water was measured directly using a K<sup>+</sup> meter (LAQUAtwin B-731; Horiba, Kyoto, Japan). The LK lettuce and normal leaf lettuce were cut into small portions (12 and 24 portions, respectively; each portion measuring 2 g). Twelve portions of the normal leaf lettuce were soaked in water for 30 minutes, and the water droplets on the surface

of the lettuce were removed with paper towels. The samples were homogenized with 25 mL of 1% HCl and incubated for 1 hour at room temperature. The samples were then filtrated and neutralized with 1N NaOH. The filtrates were used to analyze potassium concentration. The data on potassium contents were expressed as mg/100 g lettuce.

### Measurement of nutritional contents

The samples were analyzed for nutrient composition (e.g., moisture, protein, fat, carbohydrate, fiber, sodium, calcium, magnesium, vitamins, and nitrate nitrogen) using the official methods for food analysis<sup>8</sup> provided by the Fukushima Food Analysis Center. These methods were the oven-dry method for moisture; the Kjeldahl method for protein; the acid hydrolysis method for crude fat; the enzymatic-gravimetric method for dietary fiber; atomic absorption spectrometry for sodium, calcium, and magnesium; and the high-performance liquid chromatography method for vitamins A, B<sub>1</sub>, B<sub>2</sub>, C, and E. The total carbohydrate content was calculated by difference after determining the other proximate components. Energy was calculated according to the following equation:

$$\begin{aligned} \text{energy (kcal)} = & 4 \times (\text{g protein}) + 4 \times (\text{g carbohydrate}) \\ & + 9 \times (\text{g fat}). \end{aligned} \quad (1)$$

### Evaluation of taste characteristics

The panel for sensory evaluation included 29 young trained members (students from the University of Shizuoka, Shizuoka, Japan; 26 female and 3 male panelists aged 20–23 years), because healthy young individuals have higher taste sensitivity than middle-aged and elderly individuals. Because patients with kidney disease may have dysgeusia, we did not recruit such patients in this study. One piece of each lettuce leaf was put into a separate plastic cup and served to each panelist as a sample. The samples were assigned the letter A for LK lettuce and B for normal leaf lettuce. The sensory evaluation was performed blindly. The panelists were provided with water as a palate cleanser between samples. The order that the samples were taken in was decided individually by each panelist. First, the panelist evaluated the color and flavor of each sample, followed by texture and taste. Finally, the panelist evaluated his or her overall preference level for the sample. After their palates were neutralized, the panelists evaluated another sample following the same procedure.

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