実践報告

Introduction to an agenda in the laboratory course for applied food science
—Preparation and development of sports drinks—

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Abstract

At Musashigaoka College, the "Preparation and Development of Sports Drinks" class is conducted in the laboratory course for applied food science. This paper introduces our approach in this course, and reports student awareness regarding sports drinks, together with the educational effectiveness as well as student's evaluation of the laboratory course.

Keywords: sports drinks, applied food science, educational effectiveness, sports nutrition

Introduction

The Health and Nutrition Course, Department of Health Life Science, Musashigaoka College, implements versatile programs to help students acquire various licenses such as a nutritionist, a food specialist, a health care leader, a 2nd class home helper and a peer helper. Approximately 60% of all the graduates of this college have obtained employments as nutritionists. In recent years, however, many students express their interest in obtaining jobs such as sports instructors, quality control management personnel as well as research/development assistants in food-related companies. Especially, sports nutrition has been growing as a field of interest; furthermore, many students are familiar with related keywords such as "sports drinks" and "sports food supplements". In response to these recent trends, our food science laboratory programs introduced "Preparation and Development of Sports Drinks" as an agenda in the course. This report presents class data of 2003 and 2004, and examines student interests with respect to sports drinks.

Purpose of the Class and Experimental Flow

1. Preparation of liquid solutions

This laboratory course teaches throughout basic chemical manipulations such as weighing and dissolving of chemical reagents. Our students possess little experience in terms of weighing chemical compounds in mg units. In this class, students learn proper technique associated with weighing chemical reagents in mg amounts with electronic balances located in a common equipment room.

2. Organoleptic evaluation and development of prescription

Students prepare sports drinks with a specified formulary (standard sports drinks). They taste and compare the products with several commercial sports drinks in the organoleptic way. Subsequently, small amounts of gustatory ingredients (food or food additive grade) they used in the drinks are tasted, and evaluated. Then, they discuss the improvement of the standard prescription of the sports drinks they prepared, using the data obtained with the organoleptic evaluation in each group. Following the preparation of improved pre-

scription, organoleptic evaluation is conducted again. Students learn taste of various gustatory ingredients and food additives; moreover, students also experience a simulated development of a product in the sports drink industry.

Materials and Methods

Energen (Otsuka Pharmaceutical Co., Ltd.), Pokarisweat (Otsuka Pharmaceutical Co., Ltd.), Aquarius (Coca-Cola Japan Co., Ltd.) and Aquarius Lemon (Coca-Cola Japan Co., Ltd.) were used as reference commercial sports drinks. These sports drinks in powder form were dissolved in distilled water following instructions on the packages. As standard sports drinks, the following two sports drinks were formulated. Standard sports drink A: we prescribed utilizing ingredient labels on commercial sports drinks above (3.6 g sucrose, 3.6 g glucose, 6.6 mg sodium chloride, 43.03 mg potassium chloride, 600 mg ascorbic acid, 110.8 mg sodium citrate dihydrate, 17.68 mg calcium lactate and 11.99 mg basic magnesium carbonate were dissolved in distilled water and diluted to total volume of 100 ml). Standard sports drink B: we prescribed based on data provided by Otsuka Pharmaceutical Co., Ltd., and modified to fit the laboratory experiment conditions (3.8 g fructose, 3.8 g glucose, 76 mg sodium chloride, 3 mg potassium chloride, 40 mg ascorbic acid, 197 mg citric acid, 92 mg sodium citrate dihydrate, 12 mg monosodium glutamate, which was substituted for commercial Aji-no-moto, 21 mg calcium lactate and 26 mg basic magnesium carbonate were dissolved in distilled water and diluted to total volume of 100 ml).

As compounds that influence sports drink taste strongly, sucrose, glucose and fructose were grouped as sweetness substances, whereas ascorbic acid and citric acid were classified as sourness substances. Sodium chloride, potassium chloride and sodium citrate dihydrate were sorted as saltiness substances and monosodium glutamate were treated as a "umami" (flavor-enhancing) substance.

Results and Discussion

Contents of gustatory ingredients in standard sports drinks A and B, as well as in the novel sports drinks prepared by students, are displayed in the Figure. The prescribed amounts of each gustatory ingredient by students and their awareness or preference for the component are discussed bellow.

1. Sweetness

In the class of 2003, one group formulated drinks with no sweetness and three other groups with lower sweetness in comparison to standard sports drinks. However, the remaining seven groups from 2003 and most groups of 2004 formulated drinks with nearly similar excessive sweetness compared to standard sports drinks. Sports drinks formulated in the laboratory course were prepared with distilled water at room temperature; the organoleptic evaluation was also conducted at room temperature. Normally, sports drinks are consumed at colder temperatures (5-10 ℃). On the other hand, sweetness degree of monosaccharides varied depending on temperature; in particular, fructose exhibited high temperature dependency. Fructose sweetness at 40℃ was approximately 60% weaker than sweetness at 5℃[1]. Standard sports drink B contains fructose; consequently, sweetness may have been diminished because of the room temperature, resulting in the dissatisfaction of students with respect to sweetness.

As in standard sports drinks, many of the student's drink formulas contained two kinds of sugar. Twenty-seven, 20 and 18 of 31 groups employed glucose, fructose and sucrose, respectively. Degree of sweetness of these sugars in the range from room temperature to body temperature is the greatest in fructose, followed by sucrose and glucose, respectively[1]. Students described sweetness

of fructose and sucrose as "rich", "taste lingers behind" and "persistent", whereas sweetness of glucose was described as "plain", "light" and "crisp". This phenomenon is probably attributable to each degree of sweetness; moreover, students appear to have combined the weak taste of glucose and the strong taste of sucrose or fructose.

Sugar content in sports drinks plays significant roles in energy supplementation, in osmotic adjustment and also in the control of energy absorption rate. Efficacy in these functions of each sugar type has also been investigated[2]. However, in this laboratory course, sugar is treated solely as a taste substance; thus, the significance of sugar in sports drinks is not explained. In the discussion of term paper, only a few student mentioned keywords such as "energy source" and "soothing effect".

2. Sourness

Amount and composition of sourness ingredients differ markedly between standard sports drinks A and B. Drink A contains large quantities of ascorbic acid but no citric acid. Drink B contains small quantities of ascorbic acid and moderate levels of citric acid. Overall sourness of drink A is stronger; moreover, many students described drink A as "crisp" and "sour". Drink B is described as "weakly sour" and "sweet". The type of sports drink formulation is dependent purely on individual student preference; however, it appeared that many students preferred sports drinks characterized by stronger sourness.

Vegetables and fruits are primary sources of ascorbic acid, whereas Japanese plums and lemons are major sources of citric acid[1]. Direct organoleptic evaluation of each ingredient demonstrated a higher degree of student preference for ascorbic acid relative to citric acid, which was probably attributable to the more intense sourness of citric acid. Furthermore, vague understanding regarding the concept that "ascorbic acid is good for health" resulted in the addition of excessive amounts of ascorbic acid in some groups. Ascorbic acid functions in collagen synthesis, stress resistance and antioxidative processes; function in terms of sports is garnering increased attention. However, at present, the effect of ascorbic acid on athletic ability remains unknown[3].

On the other hand, citric acid, which is a TCA cycle intermediate, is linked to carbohydrate and fatty acid metabolism as well as to promotion of lactic acid decomposition, which is the main product of fatigue[4]. As a consequence of these effects, citric acid is added to many health foods, including commercial sports drink such as "Citric Acid C Water" (Aristo, Co. Ltd.). Consumption of glucose and citric acid in combination immediately after exercise promotes replenishment of glycogen in muscle tissue and liver[5]. Few students mentioned the importance of citric acid; these students demonstrated less awareness of citric acid function in comparison to health awareness of ascorbic acid. However, knowledge of ascorbic acid among students was extremely vague, as evidenced by ambiguous statements such as "good for health". This course is offered in the first year of college, thus, it clearly revealed limited knowledge levels among students in terms of functionality associated with food ingredients.

3. Saltiness

Many salts comprised of alkaline metals and halogen, and display salty taste; however, as a gustatory substance, no other substance matches the salty taste of sodium chloride[1]. Potassium chloride is characterized by bitterness in addition to the strong salty taste; as a result, KCl was not popular among students. Saltiness attributable to sodium citrate is weak; thus, it failed to induce a strong taste impression.

Sodium and potassium are fundamental ingredients in sports drinks for replenishment of electrolytes that are lost due to sweating during exercise[2]. Commercial sports drinks are not specially catego-

rized; thus, they are commonly treated as regular beverages. However, normally, other beverages do not contain salty taste; therefore, saltiness can be considered as a specialized characteristic of sports drinks. Students were familiar with saltiness of sports drinks; no student demonstrated strong disfavor with respect to beverage saltiness, although approximately 1/3 of the groups reduced the saltiness taste. No student mentioned saltiness other than in terms of gustatory ingredients in term papers.

4. "Umami"

Monosodium glutamate is included in standard drink B but not in standard drink A. Threshold level of glutamic acid is 13 mg/100 ml[1]. Glutamic acid concentration in standard drink B is 12 mg/100 ml, which is below the threshold. In case where monosodium glutamate and sodium chloride co-exist, the flavor-enhancing effect increases and saltiness diminishes based on contrast effect as well as synergy effect[1]. These effects may be projected in standard drink B. However, many students disfavored the taste of monosodium glutamate in direct organoleptic evaluation. Only nine of 31 groups introduced monosodium glutamate to their sports drinks. Even in nine groups who added monosodium glutamate, the amount added was either same or less compared to the standard drink.

Future Goal

The student ratings of teaching conducted in 2004 revealed the most positive student response for this theme such as "enjoyable" "interesting" and "easy to understand" among other 15 laboratory themes. Students learned basic chemical experiments and experienced a simulated product development process. However, due to limited class time, sports drinks could only be treated as regular beverages. This situation may have evoked an unsatisfying impression in those students displaying a high awareness of the field of sports nutrition. Fundamentally, sports drinks are formulated with very specific purposes; additionally, many investigations aimed at the proper amount of consumption based on the type of exercise and timing of intake[6]. Furthermore, recent trends demand an ergogenic aid (substances that enhance sports performance) or added value as supplements from sports drinks; moreover, numerous studies have been directed as such directions[2]. Incorporation of those informations into class lectures should improve this course further.

References

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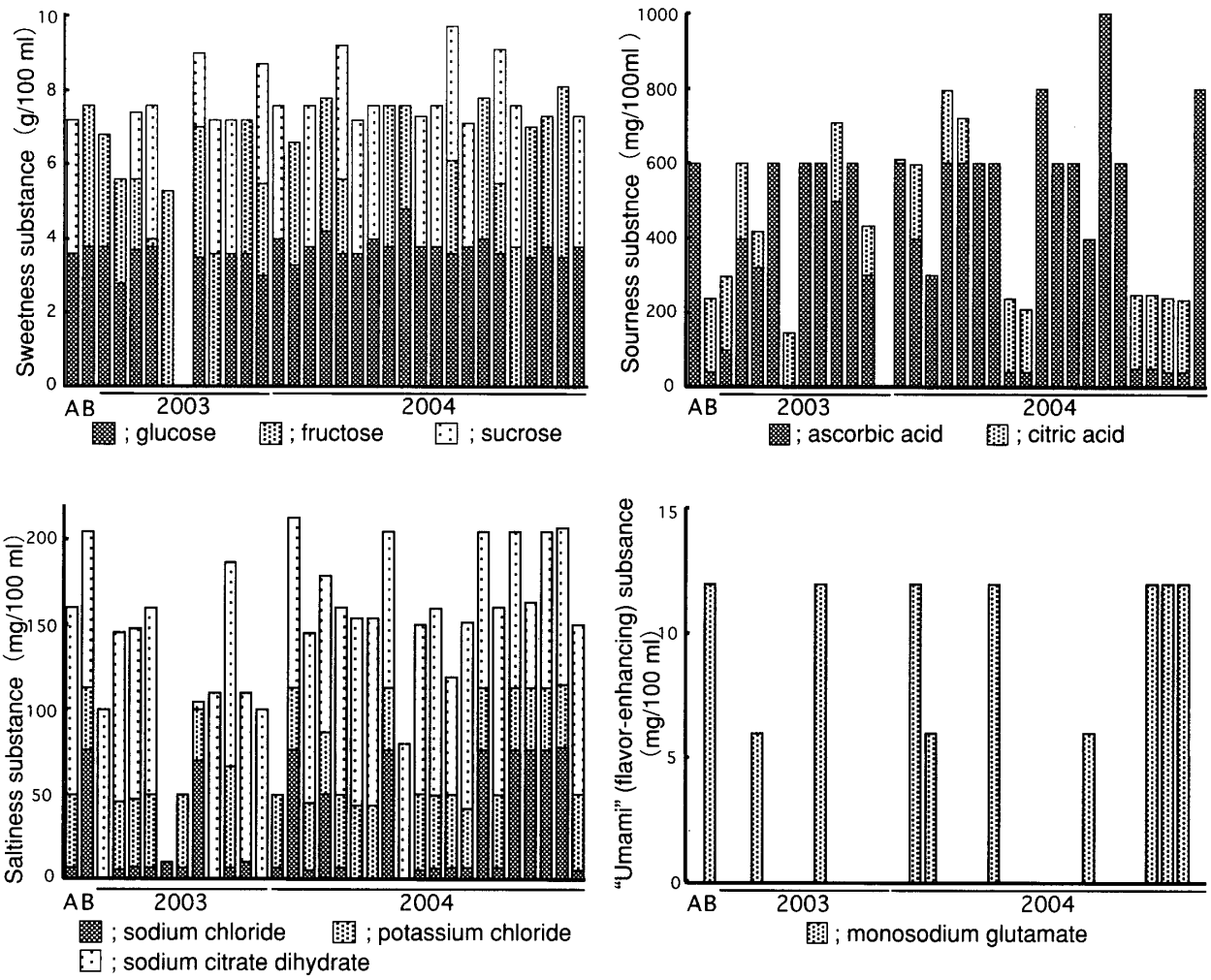

Figure. Gustatory substance contents in standard sports drinks and new sports drinks formulated by students. A shows the data of standard sports drink A composed of 3.6 g sucrose, 3.6 g glucose, 6.6 mg sodium chloride, 43.03 mg potassium chloride, 600 mg ascorbic acid, 110.8 mg sodium citrate dihydrate, 17.68 mg calcium lactate and 11.99 mg basic magnesium carbonate in 100 ml volume of distilled water. B also shows those of standard sports drink B in which 3.8 g fructose, 3.8 g glucose, 76 mg sodium chloride, 3 mg potassium chloride, 40 mg ascorbic acid, 197 mg citric acid, 92 mg sodium citrate dihydrate, 12 mg monosodium glutamate, 21 mg calcium lactate and 26 mg basic magnesium carbonate were included in the same volume of distilled water. The bars above 2003 and 2004 indicate the contents of new sports drinks formulated by students in 2003 and 2004, respectively.