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Development of a nutritionally balanced, melt-in-the-mouth chocolate for patients with epidermolysis bullosa

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Abstract

Epidermolysis bullosa (EB) is a group of inherited blistering disorders that primarily affect the skin and mucous membranes of the digestive tract, which can lead to poor nutritional status. Dietary supplements and nutritional support methods, such as nasogastric tubes and gastrostomy, have been employed to improve the nutritional status of patients with EB; however, few foods suitable are for communal eating. Here, we introduce a nutritionally balanced, melt-in-the-mouth chocolate called andew, which was specifically designed for patients with EB. The andew chocolate is nutritionally superior and melts more easily than traditional chocolates; thus, it is suitable for patients with EB who are prone to oral erosions. Patients responded more favorably to the taste and texture of andew than to those of other dietary supplements. Not only does andew provide nutritional benefits, but it also promotes communal eating with family members and friends, which could positively impact patients' mental health.

1. Introduction

Epidermolysis bullosa (EB) is an inherited skin disease caused by mutations in genes that encode basement membrane zone components. The disease is characterized by mucocutaneous fragility and blister formation in response to minor stimuli, putting patients at high risk of malnutrition because of decreased food intake and increased nutrient demand. Nutritional care, achieved through the consumption of energy, protein, and vitamins, represents a crucial treatment strategy for patients with EB (1, 2). Because of the continuous cycle of wounding and regenerating skin, these patients require nutrients for skin regeneration, necessitating higher nutritional intake compared with healthy individuals. However, oral erosions and esophageal strictures often lead to unsatisfactory feeding in patients with EB. Nutritional support methods, such as nasogastric tubes and gastrostomy, are utilized in severe cases. Dietary supplements, predominantly in liquid form, have been developed for patients who are unable to ingest foods. However, these supplements are not typically designed for communal eating with family members and friends.

In this paper, we introduce a novel chocolate called andew, which has a balanced nutritional profile that is particularly beneficial for patients with EB. The andew chocolate is characterized by its ability to melt in the mouth, making it ideal for patients with oral erosions. Furthermore, we administered a questionnaire about andew to patients with EB, which confirmed its non-inferiority to other dietary supplements.

2. Methods

Patients and Chocolate

Twenty-three patients with EB (eighteen with recessive dystrophic EB, one with dominant dystrophic EB, three with junctional EB, and one with EB simplex)

participated in the study. The andew chocolate used in this study was provided by SpinLife, Sapporo, Japan.

Patients were given 90 bars of andew and were instructed to consume one bar (50 g) three times daily, providing a total of 923 kcal per day (see Results).

To compare andew with traditional dietary supplements, the patients answered questionnaires regarding taste, texture, market price, and overall assessment. The study was approved by the institutional review board of the Hokkaido University Graduate School of Medicine (ID: 22-0044).

Chocolate Melt and Drip Test

The chocolate andew and three other types of commercially available chocolate (designated as X, Y, and Z) were placed on a hot plate at 37 °C, and the degree of expansion was compared after melting. Subsequently, the chocolates were placed vertically, and the distance the chocolate dripped over a 30-second period was measured.

3. Results

Development of a Novel Chocolate for Patients with EB

Nutrition intake is vital for patients with EB to maintain skin health and quality of life (3, 4). Therefore, we chose to develop a novel food item with a soft texture, optimal nutrient profile, and high palatability. We focused on chocolates because they allow nutrient manipulation and are suitable for communal eating. We developed a novel, nutritionally balanced chocolate that contains 29 ingredients, including cacao, almonds, chia seeds, coconut, soybean flowers, matcha, kelp, and various vitamins and minerals

(Fig. 1a; Table 1). A 100 g serving of andew provides 615 kcal of energy, 10.2 g of protein, 48.7 g of fat, 9.6 g of iron, and 580 mg of potassium.

Comparison of Melting Area Size and Dripping Distance After Melting

Not only is andew nutritionally balanced, but its ingredients also allow it to melt in the mouth, an ideal property for patients with EB. We compared andew with other common chocolates (X, Y, and Z) and found that andew and chocolate X melted rapidly and spread widely after melting (Fig. 1b). By contrast, chocolates Y and Z did not melt within 10 minutes on the 37 °C hot plate. The melted chocolates were then positioned vertically, and andew dripped further than chocolate X (Fig. 1c), confirming its ability to melt in the mouth.

Patient Questionnaire Scores

We subsequently surveyed the participants to compare andew with traditional dietary supplements regarding taste, texture, market price, and overall assessment. The andew chocolate received favorable responses regarding taste, texture, and global assessment (Fig. 1d). Notably, a bar of andew costs approximately USD 8 (JPY 980), which is more expensive than other supplements.

4. Discussion

Nutrition management is a critical component of EB treatment, as malnutrition exacerbates disease progression. Particularly, oral erosions and esophageal fibrosis reduce the overall amount of food intake. The andew chocolate developed in this study can help maintain the physical condition of patients because it provides adequate caloric intake as well as essential proteins, vitamins, and minerals (Table 1). It also easily melts in the mouth, which is advantageous for patients with EB because it allows

for easy and painless consumption. Furthermore, eating chocolate can have positive psychological effects when shared with family or friends.

Conventionally, chocolate is made with cacao, cacao butter, and sugar. However, andew also incorporates almonds, chia seeds, poppy seeds, coconuts, soybean flowers, and matcha. The fatty acid content differs between cacao butter and these added ingredients, and the melting point of the fatty acids in almonds is lower than that of cacao butter (5), which is one of the reasons why andew tends to melt more easily than other chocolates. Additionally, the type of oil used can impact meltability (6). Both andew and chocolate X used cocoa butter exclusively, whereas chocolates Y and Z incorporated cheaper vegetable oils. These melting properties may contribute to the perception of a smoother mouthfeel when patients consume andew. In clinical settings, enteral nutritional supplements are the most common option for patients with eating difficulties because of their diseases or treatment, and patient satisfaction regarding meal enjoyment is low (7). Although patients responded favorably to andew, its cost must be reduced because cost is a critical factor in maintaining a good physical condition (7).

In conclusion, andew offers a superior option to traditional dietary supplements for patients with EB. Because chocolate is easy to consume, it is especially suitable for pediatric patients and beneficial for managing the physical condition of patients who are prone to nutritional deficiencies (8). Patients with oral erosions due to chemotherapy, autoimmunity, or oral cancers might also benefit from andew. Future research is needed to assess biochemical data after andew consumption to determine if this supplement can improve nutritional status and reduce anemia.

Figure Legends

Figure 1. Chocolate “andew”, melting assays, and surveys.

The andew chocolate (A). The area of spread after melting each chocolate (B) and the distance the chocolate dripped due to gravity after melting (C); $*0.01 < p < 0.05$, Mann–Whitney U test. Patients rated andew compared with traditional dietary supplements in four aspects: taste, texture, market price, and overall assessment (D).

Table 1.

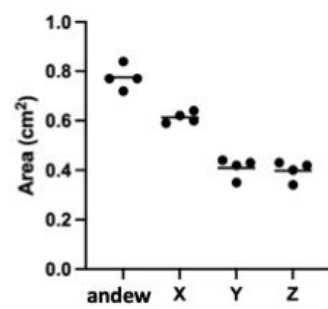
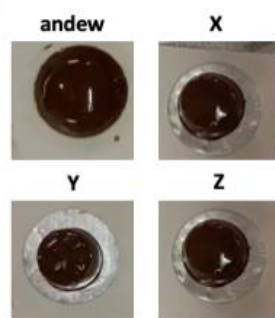
The types and amounts of ingredients contained in 100 g of andew

Fig. 1

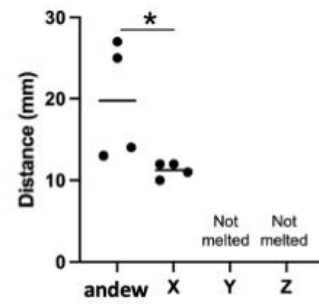
A



B



C



D

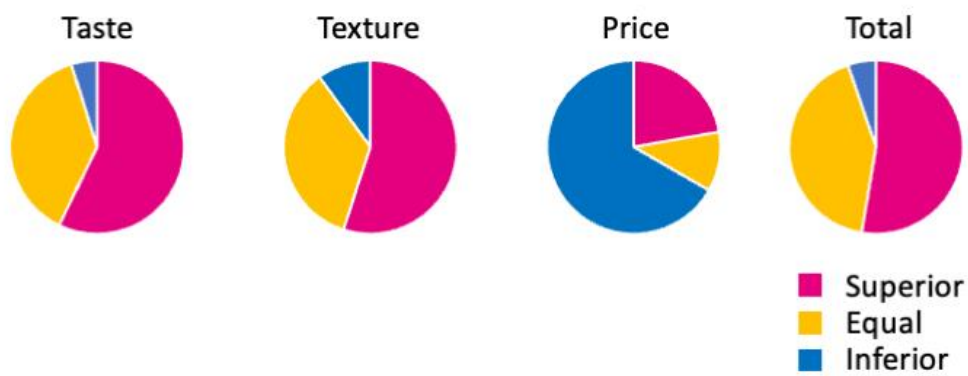


Table. 1

The kind and amount of nutrients contained in 100 g "andew"

Nutrition name	amount	Nutrition name	amount
Energy	615 kcal	VitaminA	197 µg
Protein	10.2 g	VitaminB1	1.3 mg
Fat	48.7 g	VitaminB2	0.81 mg
Carbohydrate	38.3 g	VitaminB6	1.11 mg
Fiber	8.7 g	VitaminB12	5.3 µg
Sodium	29 mg	VitaminC	12 mg
Calcium	160 mg	VitaminD	3.75 µg
Phosphate	260 mg	VitaminE	4.8 mg
Iron	9.6 mg	Niacin	6.1 µg
Potassium	580 mg	Pantothenic acid	3.09 mg
Zinc	170 mg	Folic acid	35 µg
Copper	0.53 mg	Biotin	16 µg
Chromium	170 µg	VitaminK	35 µg
Selenium	9 µg	Molybden	35 µg
Manganase	2.8 mg		

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Declaration of competing interests

Kosei Nakamura is a founder of SpinLife.

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