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Studies on Improving the Amount of Animal Protein Intake among the Elderly Application of a Meat Softener to Chicken Eggs

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A meat softener (MS) that uses enzymes to soften solid food, such as meat was developed to meet the needs of the elderly. We applied the MS to liquid egg product to extend protein sources for elderly nutrition. Several conditions were tested for usage quantity and time of treatment. Furthermore, we examined MS have any effectiveness for the improvement of eating rates for egg dishes for the elderly in a nursing home. Different concentrations of MS were added to the liquid egg product. Different treatment times were used for the 1% MS. After this, omelets were cooked. The degree of digestion of protein was analyzed using SDS-PAGE. 48 subjects participated in sensory tests. The results were analyzed to evaluate optimal concentration and treatment time for MS. A survey was conducted to examine the eating rate of the elderly in a nursing home. All samples treated with MS were significantly softer than control. Protein samples from the omelets were concentration-dependent and showed low molecular weight peptide. No difference was seen in rupture property from the addition of MS. Results from the sensory tests indicated that a 1% concentration and an application time of 60 minutes was optimal. Eating rates for the omelets with MS was higher 6.3 % than the one of control day among home residents and 2.6% among people who use day care service. It was suggested that egg using MS could become easy to eat. It might be effective for improvement of eating rates for the elderly.

Introduction

Conventionally, thinly chopped foods, food pastes, and other foods made from crushed ingredients are served to elderly persons with reduced chewing/swallowing ability. However, such meals do not increase appetite in terms of taste, smell, appearance, or texture. A tenderization technology that uses enzymes to break down food constituents without affecting food shape (enzymatic decomposition) has recently been developed and may be useful in preparing meals suitable for elderly persons with reduced chewing/swallowing ability. We previously studied meals in which meat tenderizer was used on solid food ingredients (meat and fish); in the present study, we focused on a liquid food ingredient, chicken eggs. Similar to meat, eggs are a highly nutritious food and important protein source and are frequently used in various dishes. Using a meat tenderizer on eggs, which are inexpensive and easy to prepare, may expand the range of foods that can be consumed by elderly people. Proteolytic enzymes have been used in meat and fish, but there are few reports of these enzymes being used in liquid eggs.

In this study, we investigated the appropriate concentration of meat tenderizer (hereinafter, "M") to add to liquid eggs as well as incubation time. The purpose of the study was to determine the effects of using M on a

Japanese thick omelette served at a nursing home (hereinafter, the "facility") in city T.

Compared with meat and fish, egg dishes are soft, even when heated, and thus are considered easy for elderly persons to eat. However, to prevent food poisoning, eggs served in cafeteria-style dining situations must be heated to a central temperature of 75°C for at least 1 min. If heated for longer, the surface of the egg hardens and the egg becomes unpleasant to eat. M is a powder that can be dissolved in liquid egg. The ingredients and nutritional information of M are shown in Table 1.

Materials and Methods

Ethical considerations

This series of studies was approved by the facility as well as the Research Ethics Committee at the University of Kochi (Health and Nutrition Research Ethics NO. 2011-05).

Study of conditions for the use of meat tenderizer M

The physical properties of the Japanese thick omelette were measured with a creep meter; Na quantitative sensory testing was conducted by atomic absorption measurements; qualitative analysis of protein was performed by electrophoresis; and the concentration of M

dissolved in liquid egg and the refrigerator incubation time were evaluated.

Physical measurements by creep meter

Cooked Japanese thick omelette was used as the test material. The device used was a Yamaden creep meter RE2-33005B (Tokyo, Japan), and load was measured at distortion factors of 20%, 50%, and 70% with a No. 49 wedge-shaped plunger at a speed of 1 mm/s.

Sodium measurement (atomic spectrometry)

A YAMATO SCIENTIFIC Murrelle Furnace FO810 (Thermo Fisher Scientific, Inc., Waltham, MA, USA) iCE3300 was used. The test material was heated to ash at an ashing temperature of 450°C and diluted by a factor of 5. Measurement was performed at a wavelength of 589.1 nm.

Sensory testing (scoring method)

Sensory testing was conducted by 20 facility employees using a scoring method. The tested attributes were hardness, easiness of swallowing, taste, and general evaluation, which were scored on a 5-level scale from -2 to +2. The test material was Japanese thick omelette with an M concentration of 1% and a control incubation time and incubation times of 30, 60, 90, and 120 min. For analysis, Excel Statistics (2010) was used and a Bonferroni multi-comparison test was performed.

Qualitative analysis of proteolysis by electrophoresis

The power supply device for electrophoresis was an AE-6530 Rapidas Mini-Slab electrophoresis layer and WSE-1100 PageRun-R, slab electrophoresis layer AE-6530 (ATTO, Tokyo, Japan), and the gel was an AE-6000 ready-made gel for electrophoresis (E-Pagel model E-T15S (tricine) gel concentration 15%, 14 samples, ATTO), which were used for qualitative analysis of proteins by sodium dodecyl sulphate-polyacrylamide gel electrophoresis. Thinly chopped test material (3.0 g each) and 12 mL of phosphate-buffered saline were stirred in a homogenizer. One hundred microliters of each prepared test material were measured and mixed with the same quantity of sample buffer (buffer; 2-mercaptoethanol was used as the reducing agent) and then the samples were heated at a low boil with temperature 50 degrees to 60 degrees for 5 min. After a brief cooling period, the samples were mixed by vortexing and centrifuged for 5 min to precipitate insoluble materials. The supernatant was subjected to electrophoresis.

Consumption percentage after meat tenderizer addition

The subjects were persons who used the facility (residents and day-service users). The meal studied was rice, thick Japanese omelette, kinpira-style sautéed burdock, cucumber, and imitation crab meat dressed with sake, soy, and vinegar sauce, and clear soup. The

preliminary study (control) was conducted on October 22, 2013 and intervention was performed on December 4, 2013.

During the control, there were 111 residents and 30 day-service users, while during the intervention, there were 102 residents and 32 day-service users. The uneaten portion of each dish was collected on each floor (residents, day-service users) and weighed, and then the weight of each form (normal, roughly chopped, chopped, blended) of the dishes was measured. The total quantity was multiplied by the number of people to calculate the percentage consumed.

Results and Discussion

Measurement of physical properties

For physical property measurements at different concentrations and constant incubation times, a significant difference was observed between the control and samples containing M (1%, 2%, 3%, 5%) (Fig. 1). When physical properties were measured according to incubation times, a significant difference was observed between the control and samples containing M (30, 60, 90, and 120 min) (Fig. 2).

Measurement of Sodium content

A positive correlation was observed between added Sodium content and Sodium quantity (Fig. 3). As Sodium addition increased, Na content increased.

Sensory testing

Facility employees found control eggs to be inferior to those prepared under other conditions in terms of taste, ease of swallowing, hardness, and general evaluation (Fig. 4). Eggs treated for 60 min were significantly preferred over eggs treated for 30 min ($p < 0.01$).

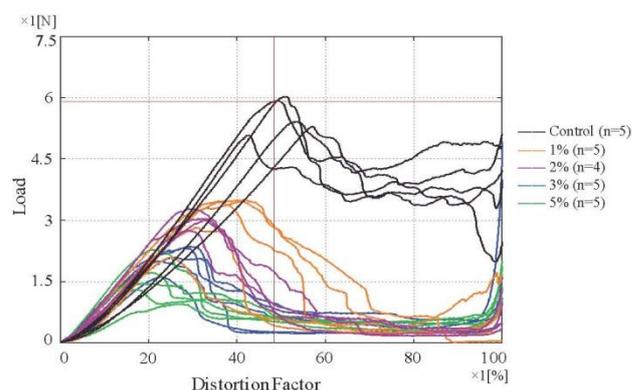


Fig. 1. Physical properties of eggs (physical properties according to differences in M concentration, 60-min incubation time)

State of proteolysis

A concentration-dependent increase in low-molecular-weight bands was observed, indicating an increase in low-molecular-weight molecules (Fig. 5). The content of a

protein of approximately 45 kDa began decreasing markedly at 1% M and was predicted to be ovalbumin, the primary protein in egg white.

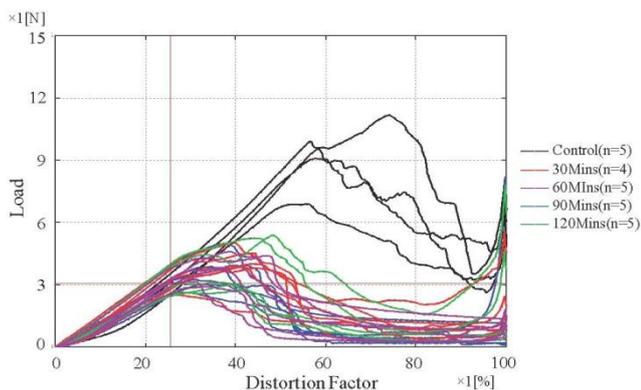


Fig. 2. Physical property measurements of eggs (1% M added) with constant incubation time

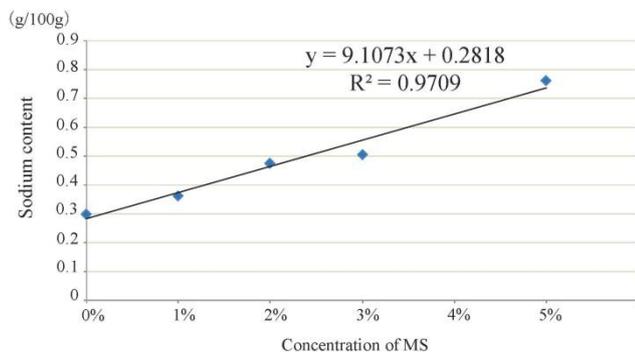


Fig. 3. Sodium content according to differences in the concentration of M added to the eggs

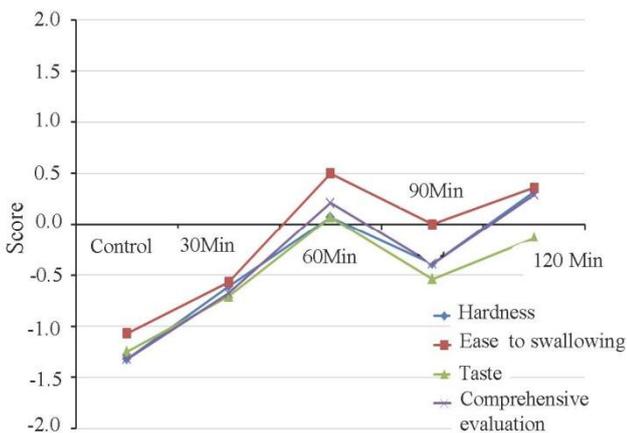


Fig. 4. Sensory test results (facility employees) for 28 subjects

Bands at approximately 120, 90, 75, and 50 kDa began disappearing at 1% M, and each disappeared at an M concentration of 3–5%. The band at approximately 60 kDa became fainter at an M concentration of 5%. The results are shown in Figs 6 and 7. The percentage of the main dish, Japanese thick omelette, consumed by

residents was 83.5% during the control period but 89.8% during the intervention period, with an increase of 6.3%.

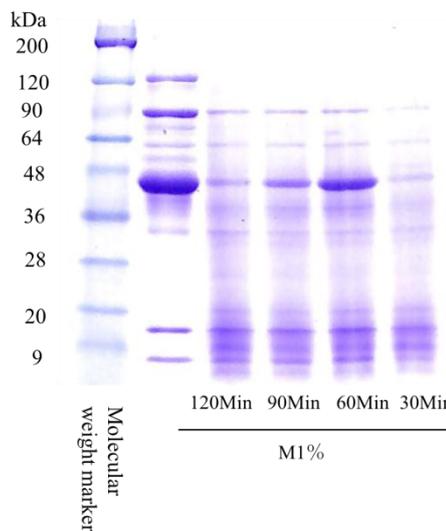


Fig. 5. Analysis of proteolysis status by electrophoresis

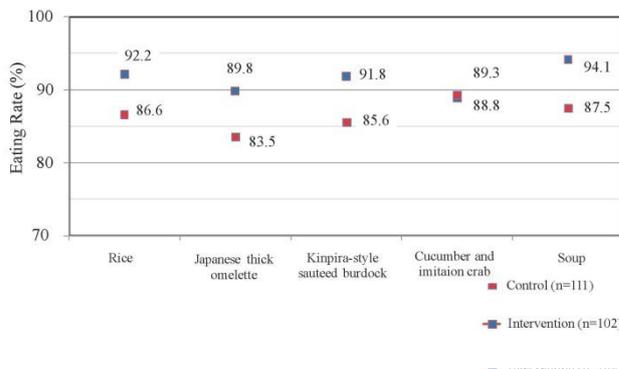


Fig. 6. Percentage consumed of meals with Japanese thick omelette (residents)

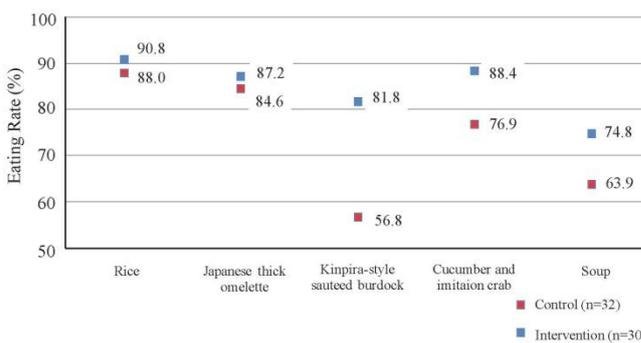


Fig. 7. Percentage of meals with Japanese thick omelette consumed (day service)

The percentage consumed also increased for the staple dish [rice] by 5.6%, side dish of kinpira-style sautéed burdock by 6.2%, cucumber and imitation crab by 0.5%, and soup by 6.6%. Among day-service users, the percentage of each dish consumed increased from the control to the intervention group: a 2.6% increase for the

Japanese thick omelette from 84.6% to 87.2%; increase of 2.8% for the staple from 88.0% to 90.8%; 25.0% increase for kinpira-style sautéed burdock from 56.8% to 81.8%; and 11.5% increase for cucumber and imitation crab, from 76.9% to 88.4%.

Depending on the concentration of the added meat tenderizer M, the eggs became soft, and a shift to lower molecular weight molecules was observed in the qualitative analysis of protein by electrophoresis.¹

The ability to simply dissolve meat tenderizer directly into liquid egg satisfies the conditions required for introducing the tenderizer in cafeteria-style food facilities, as there will be minimal impact on the operation processes and mass preparation.

Meat tenderizer S contains a high Na content and is unsuitable for direct dissolution in liquid eggs, but meat tenderizer M has less than 0.8 g of Na per 100 g, even when added to a concentration of 5%; thus, M can be easily added to liquid egg without the need for seasoning adjustments. In the sensory tests, the material treated for 60 min had a high score, with the highest scores for ease of swallowing, and therefore is considered suitable for elderly persons. The decision was made to use M in Japanese thick omelette at the facility, with the preparation conditions of 60-min incubation in a refrigerator at a concentration of 1%.

The physical property and electrophoresis experiments showed that by adding a meat tenderizer to eggs, the papain enzyme in the tenderizer denatured the protein, softening the eggs. M also increased the percentage of eggs consumed. Japanese thick omelette is a dish that is already soft, but the use of a meat tenderizer made it easier to swallow, resulting in a smooth and pleasurable dining experience, according to the participants in the sensory tests. In this study, the percentage of Japanese thick omelette consumed increased by 6.2% among residents, a greater increase than among day-service users. This is probably because residents have decreased eating and swallowing abilities and require a higher level of nursing care compared with day-service users; hence, they found the dish easier to eat.

Therefore, adding eggs as an ingredient to the conventional menu increased the quantity of animal protein consumed by users of the facility.

Products for the elderly that use enzymes have previously been developed, but are costly and require conditions that affect facility operations, and thus these products could not be easily incorporated by the facility. Additionally, while previous studies determined the nutritional status of facility residents and day-service users, no studies have aimed to increase consumption percentages by examining the conditions of commercially available meat tenderizers. There are no reports in which meat tenderizers typically used for meat were used in liquid egg to change its physical properties and or studies of introduction of meat tenderizer in a facility. The introduction of meat tenderizer at the target facility in this

study increased the percentages of meat and eggs consumed, showing that meat tenderizer can increase animal protein intake.

Tanaka et al., reported a significant increase in serum albumin in elderly persons aged 65 years and older who consumed only 1–3 eggs or egg whites per day for 1–8 months.⁶ This supports that continually incorporating eggs with good-quality protein in the dining menu while also making them softer and easier to eat contributes to good nutritional management in elderly persons, who tend to have reduced digestion and absorption abilities.^{7,8}

To prevent poor nutrition and sarcopenia, animal protein and vitamins must be consumed⁹. Planning and monitoring meals suited for specific groups is expected to help prevent these conditions. Our future studies will focus on the addition of meat tenderizer in a greater variety of foods.

The limitations of this study include that intervention could only be conducted once at lunch on each day. The number of interventions was limited because the consumption percentage was only measured during the day when a managing nutritionist was available.

Conclusions

In cafeteria food facilities for the elderly, increasing food intake leads to sufficient animal protein and energy intake. Increased food intake is expected to improve the quality of life/activities of daily living and extend healthy life expectancy.

Acknowledgement

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Conflict of Interest

All the authors declare that they have no conflict of interest.

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