Archives of Food Science and Technology

Research Article
Published: 27 Jan, 2020

Novel Savory Umami Tasting Snacks Designed as a Strategy to Increase Protein Intake among Hospitalized Patients at Nutritional Risk

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Abstract

Background and Aims: Malnutrition in hospitalized patients is a highly prevalent problem, which is associated with many adverse consequences. Snacks are recommended to malnourished patients and patients at nutritional risk in the approach to achieve sufficient food intake. This study objective was to examine whether novel savory umami-tasting snacks could improve protein intake among patients and further explore if the increased protein intake could contribute to at least 20% of total daily protein requirements.

Methods: Four savory protein-rich snacks containing hydrolyzed beef protein were developed and offered to patients two times daily at the Departments of Oncology and Neurology. Nutritional intake was measured using the hospital standard food record scheme in a Control Group (CG) and in an Intervention Group (IG) and compared to individual protein requirements estimated for each patient.

Results: 28 and 31 patients participated in the CG and the IG, respectively. Mean protein intake when eating two snacks was significantly increased in IG. However, the number of patients reaching at least 20% of total daily protein requirements when eating two snacks was not significantly increased in IG compared to CG.

Conclusion: Despite a significantly increase in protein intake, the majority of the patients did not achieve the recommended intake of protein, which outlines the necessity to continuously try to improve nutritional intake by new initiatives.

Keywords: Malnutrition; Nutrition; Snack; Food intervention; Protein and energy enrichment/ fortification; Umami

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Received Date: *22 Dec 2019*
Accepted Date: *06 Jan 2020*
Published Date: *27 Jan 2020*

Citation:
Thomsen C, Bundgaard Anker CC, Holst M, Mortensen MN, Sanden M, Skadhauge LB, et al. Novel Savory Umami Tasting Snacks Designed as a Strategy to Increase Protein Intake among Hospitalized Patients at Nutritional Risk. Arch Food Sci Technol. 2020; 1(1): 1004.

Introduction

Disease Related Malnutrition (DRM) in hospitalized patients is a common problem worldwide with a prevalence of approximately 40% [1-4]. DRM has negative consequences both for the patient and for the health care system. It affects the patient´s state of health by increasing infection risk, causing a loss of muscle mass and fat mass and impairs Quality of Life (QoL) [5-7]. This leads to increased morbidity, mortality and longer hospital stays, and increased hospital costs [3,4,8-11]. Dietary protein is important to support good health, promote recovery from illness, and maintain physical function as the essential amino acids stimulate muscle protein synthesis. Those who have acute or chronic diseases need even more dietary protein (i.e., 1.2 to 1.5 g/kg body w/d), in contrast to recommendations for healthy adults which are 0.8 g/kg body weight/d [12-14]. Former studies have shown that it is possible to improve the intake of energy and protein in hospitalized patients with fortified meals [15-18]. Additionally, from such former studies, it seems that increasing the protein intake to a sufficient level is harder than reaching a sufficient energy intake [16-18]. In order to reach a sufficient nutritional intake, snacks are essential for patients at nutritional risk. According to Danish recommendations, snack meals should comprise a considerable contribution to the daily nutritional intake for patients at nutritional risk, corresponding to 30% to 50% of the total daily intake distributed over three servings [19]. Furthermore, the snack meals should be

individualized for the specific patient groups in terms of preferences, portion size and texture [10,20,21]. Since multiple factors contribute to malnutrition in hospitalized patients, multidisciplinary nutritional support like the use of Oral Nutritional Supplements (ONS), improved nutritional care, and/or dietary counseling, may have a positive effect on mortality and QoL in patients at nutritional risk [22]. The use of ONS in clinical practice may be consistent with improved weight and reduced mortality and reduced complications in acutely ill and older patients in particular [23-25]. However, in practice, the use of ONS has been associated with a high wastage, mainly due to patient's lack of compliance with ONS [26]. However, ONS is widely used in hospitals, but malnutrition is still prevalent, thus the effect of other supplementing strategies including protein fortification of foods, may be relevant [16]. In general, protein fortified foods are associated with a low sensory quality which leads to reduced acceptability [27]. In this context, mastering food and meal design is important in order to fulfill demands, preferences and stimulating appetite among patients at nutritional risk. Appetite, food choice and acceptance, intake, satiety and satisfaction after a meal are all factors directly linked to the sensory perception of food [28]. In addition, taste, aroma and mouth feel help to determine the amount consumed and the degree of satiety, thus possibly being decisive factors for food intake [28,29]. Dairy proteins such as whey and whey hydrolysates have been comprehensively studied and described and are among the most well-known proteins used in several segments and food applications [30-32]. Meat-based proteins in food applications have received less attention, but their popularity is increasing [30,33]. Hydrolyzed meat proteins from beef muscle meat contain all essential amino acids according to FAO recommendation [34]. This type of protein has not been investigated in an intervention study before, even though it has high nutritional value and has a high application potential in the savory kitchen where their dairy counterparts seem less applicable. Meat-based proteins are characterized by "umami" taste due to a high content of specific amino acid (glutamic acid and aspartic acid) [35,36]. This "umami" taste makes the meat-based proteins particularly promising for savory applications. Concurrently, umami taste is responsible for important nutritional signals and has been shown to increase appetite in consumer groups with special nutritional needs [29,37]. Four savory, protein-rich and umami-tasting snacks were developed for this study using hydrolyzed beef protein from muscle meat, and offered two times daily to patients at nutritional risk for an intervening period. The study aimed at examining whether these savory umami-tasting snacks could increase protein intake and further explore if the snacks could contribute to at least 20% of total daily protein requirements.

Materials and Methods

Study setting and participants

This study was designed as a pilot intervention study using a pre/post-test design with a non-equivalent control group comparing participants' protein intake from the hospital standard menu of snacks to servings of four novel savory umami-tasting snacks. The study was based on feasibility measuring nutritional intake among patients admitted to the Departments of Oncology and Neurology at Aalborg University Hospital, Denmark. The data collection took place during November and December 2017, and participants were allocated to a Control Group (CG) or an Intervention Group (IG) depending on their time of admission, thus CG data were collected in November and IG data were collected in December. Participants were patients at nutritional risk screened by the NRS-2002, 18 years or above and able to eat orally [38]. Terminal patients, patients diagnosed with cognitive dysfunction and patients who exclusively received enteral or parenteral nutrition were excluded from the study. Informed consent was obtained from all patients. The study was conducted according to the rules of Helsinki Declaration 2002. The study protocol was sent to the local ethic committee in Region Nordjylland, Denmark, which did not find it necessary for submission to the committee, according to Danish law of ethical intervention studies.

Intervention

Control group: The CG received the hospital standard snack menu which was available two times a day at 3 p.m. (afternoon) and 8 p.m. (late evening) and could be ordered from a selection of four items per day involving something sweet (e.g. cake), something salt (e.g. crisps), bread with butter and cheese and fresh fruit/yogurt. It is a predefined, three week cyclic menu providing an average of 653 kJ/156 kcal and 2.3 g of protein per serving and is served by a nurse at the department.

Product development: Four savory umami-tasting snacks were developed by Biosynergy A/S in close collaboration with the research group and occupational therapists. The occupational therapists ensured that the texture was suited for patients with chewing and swallowing problems. Furthermore, patients tasted the products multiple times during development to ensure liking using a 9 point hedonic scale. Patients' responses were evaluated and products were altered based on patients' response until a satisfactory average liking was achieved. The goal was to reach a nutritional content of approximately 10 g of protein per portion. This goal was determined as a previously study conducted at Aalborg University Hospital showed that a snack should contain at least 10 g of protein per portion in order to reach nutritional requirements for most patients [16]. The snacks were developed as a three-in-one snack based on a three-phase temperature system enabling the products to be served cold as an ice cream, temperate as a mousse or hot as a soup. This allowed the snacks to be served in different textures depending on the patients' preferences and swallowing abilities. The snacks were developed in four taste variants; bouillon, green peas, tomato/mushroom and yellow Thai curry (Table 1) and all were based on hydrolyzed beef protein. The hydrolyzed beef protein originated from muscle meat and was chosen as it contributes with a natural umami taste and all essential amino acids being present [33]. Umami taste has been demonstrated to improve nutritional status by enhancing palatability and appetite for food [37,39]. The ingredients of the bouillon variant were as follows: whey, milk, cream (21%), egg yolks, hydrolyzed beef muscle protein, sugar, insulin, emulsifier and stabilizer: CREMUDAN®. Green peas, tomatoes/dried mushrooms, and yellow curry paste were added to the respective variants. These nutritious snacks were named "Numami" as an acronym for nutrition and umami taste. Table 1 shows the nutritional content of the Numami snacks.

Intervention group: Patients in the IG were offered a Numami snack two times daily instead of the existing snack menu (afternoon and late evening). The patients either freely chose their favorite variant or a random variant was served if the patient accepted it. A member of the research group or a nurse at the departments served the snacks. If a patient wanted a cold ice cream temperature variant, it was served directly from the freezer. If a patient preferred a temperate mousse-temperature variant, it had to be thawed for 24 h in the fridge before serving. Finally, if a patient wanted a hot soup-temperature variant, it was heated in a microwave oven until reaching 70°C before

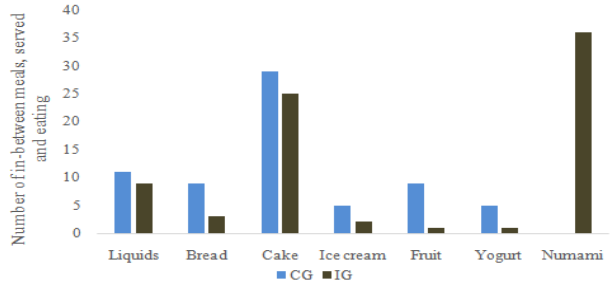

Figure 1: Number of snacks that has been eaten in CG and IG based on food category.

Table 1: The nutritional content of the four developed Numami snacks.

Nutrition Facts Serving Size: 80g	Bouillon	Pea	Tomato/ Mushroom	Thai curry
Energy (kJ/kcal)	614/147	452/108	404/97	546/130
Protein (g)	15.8	11.2	10	12.7
Carbohydrates (g)	7.5	8	6.1	9.1
Sugars (g)	7.4	4.9	5.6	8.8
Fat (g)	5	3.1	3.1	4.1
Saturated (g)	3.5	2.1	2.1	2.8
Salt (g)	0.01	0.01	0.01	0.01

Table 2: Demographic information comparing the control group and the intervention group.

Variables	Control Group	Intervention Group	p-value
Number of patients included	28	31	-
Number of registrations included	57	55	-
Gender %	M: 32%	M: 58%	
M=Male, F=Female	F: 68%	F: 42%	0.05
Age, years mean (SD)	61.6 (15.23)	64.0 (13.54)	0.44
BMI mean (SD)	25.1 (3.9)	24.3 (4.5)	0.49

serving. The patients were asked to comment their opinion of the Numami snack after eating and this information was written down.

Data collection

Demographical data: The patients' age, gender and BMI were collected from the patients' medical record after accepted participation by a nurse.

Nutritional requirements: Nutritional requirements were calculated individually from a standardized, modified scale based on the Harris-Benedict equation, as this is the standard used in the hospital. Protein requirements were calculated as 1.3 g protein per kg of bodyweight as recommended by the Danish National Board of Health for patients at nutritional risk [19].

Assessment of food intake: The nutritional intake was measured using a manual food record sheet based on the nurses' quartile nutrition registration method used in daily practice and clinical research at the Aalborg University Hospital [40]. The nutritional intake was measured for three consecutive days in both the CG and the IG with an intervening period of three weeks in between. The nurses who completed the food records for each patient were trained in doing so to ensure a high level of consistency [40]. All servings of food and drinks were registered at the time of serving, and the amount of the ingested food or drink was recorded when the tableware was collected after a meal. The nursing staff completed the food record on a record paper sheet. All food servings were registered as pieces or approximate quartile portion sizes such as 0%, 25%, 50%, 75% or 100%, respectively. Drinks were registered in approximate milliliters. An electronic calculation program already used in clinical practice at Aalborg University Hospital was used to process the calculation of the energy (kcal and KJ) and protein (grams) intake. For each patient, total daily nutritional intake, as well as daily snack intake, was calculated as the mean of 1 to 3 days dependent on number of days of participation. The mean nutritional intake was related in percentage to the daily requirements. Daily requirements were considered sufficiently met when ≥ 75% of the total daily requirements were reached. Data were collected in Microsoft Excel [41]. From the food records, it was counted from day to day how many patients said yes to the Numami snacks, and noted if patient consumed the product or not to explore the feasibility of eating these products. Food records with insufficient data were excluded. Insufficient data were defined as if more than one item (main meal, snack or drink) was missing, or was unclearly registered on the schedules, or if the patient was discharged before the end of the day.

Statistical analysis

Nutritional intake, age, gender, and BMI were compared between CG and IG using unpaired t-tests. Number of patients reaching the protein requirements of ≥ 1.3 g/kg/day or ≥ 20% protein intake at snack meals was compared using χ^2-tests between CG and IG. Significance was predetermined as $p \leq 0.05$. Data were normally distributed. Descriptive analysis was perform on all intake of snacks based on seven food categories; liquids, bread, cake, ice cream, fruit, yogurt and Numami snacks.

Results

In CG, 28 patients (16 from Oncology and 12 from Neurology) completed the food record, and 31 patients (18 from Oncology and 13 from Neurology) completed the food record in IG giving 147 eligible food record sheet. The 35 food records were excluded due to early discharge (n=16) or invalid food records (n=19), leaving 112 food record sheets (57 from CG and 55 from IG) for evaluation. This gave the possibility of 224 snack servings (114 in CG and 110 in IG). Table 2 compares the demographic information between groups. No significant differences in age (p=0.44) and BMI (p=0.49) were seen between CG and IG. A difference in gender was seen (P=0.05) with more men included in the IG than in CG. 68 snacks were served and consumed in CG out of 114 possible servings (60%). In IG, 77 snacks were served and consumed out of 110 possible servings (70%). 36 of the 77 snacks served in IG were Numami snacks (47%). Figure 1 displays the number of snacks that has been consumed in CG and IG based on food category. The most frequent comments about the Numami meals are shown in Table 3. No significant changes in mean total energy and protein needs and intakes were found between CG and IG (Table 4). The mean energy intake from the snacks was 19.7% higher in IG than CG but the difference was not significant. The mean protein intake from the snacks was significantly increased in

Table 3: The most frequent comments about the Numami snacks.

Numami Snacks Comments
"Where can I buy it? It is really good"
"I feel very full after eating it"
"Not very impressive. I would rather have something sweet"
"No thanks to more. I really don't like it"

Table 4: Mean total energy and protein needs compared to mean energy and protein intakes in total and intakes from snack meals. Number of patients reaching protein requirements of ≥ 1.3 g/kg/day and ≥ 20% intake from snack meals are additionally shown.

	Control Group (n=28)	Intervention Group (n=31)	p-value
Total energy need (kJ)[a]	5458.9 ± 1033.0	5772.6 ± 978.8	0.244
Total protein need (g)[a]	67.6 ± 11.4	69.0 ± 14.0	0.668
Total energy intake (kJ)	6260.6 ± 2166.7	6288.0 ± 2046.5	0.961
Total protein intake (g)	57.2 ± 22.0	59.6 ± 23.8	0.696
Energy intake from two snacks (kJ)[b]	550.2 ± 337.4	658.8 ± 389.6	0.268
Protein intake from two snacks (g)[b]	3.4 ± 3.4	6.9 ± 5.0	0.003
Total protein intake g/kg body weight	0.8 ± 0.3	0.9 ± 0.3	0.544
Protein requirements, ≥ 1.3 g/kg/day (n)[c]	5	13	0.04
Protein requirements, ≥ 20% from snacks (n)[d]	0	3	0.09

Data are presented as mean ± SD unless stated otherwise
[a]75% of total daily requirements
[b]Energy and protein intake from snacks served afternoon and late evening
[c]Number of patients reaching a daily intake of ≥ 1.3 g/kg/day
[d]Number of patients reaching ≥ 20% protein intake from snack meals

IG compared to CG (p=0.003). The number of patients reaching their protein requirement of ≥ 1.3 g/kg/day was significantly increased in IG (from 5 patients in CG to 13 patients in IG, p=0.04). The number of patients reaching their protein requirements of ≥ 20% protein intake from the snacks was also increased from 0 in CG to 3 in IG; however the increase was not significant.

Discussion

The results of this study showed that the mean protein intake when eating two snacks a day was significantly increased in the IG receiving the Numami snacks. However, no change in the mean total protein intake between CG and IG was observed. Nevertheless, the number of patients, who enhanced their protein intake to ≥ 20% eating two Numami snacks increased from 0 in CG to 3 in IG and additionally, the number of patients, who enhanced their total daily protein intake to ≥ 1.3 g/kg/day significantly increased from 5 in CG to 13 in IG. This indicates that specially designed meals and protein fortification can enhance protein intake and improve the nutritional status for patients. Other studies have reported significant improvement of protein intake using fortified food as well [16-18,20,42-44]. In the studies of Mortensen et al. and Beermann et al. they both developed new hospital menus regarding snacks and breakfast, respectively. Both studies demonstrated significant improvements in the number of patients reaching both total daily energy and protein requirements. In a study by Munk et al. it was found that an intervention with protein-supplemented food led to a significant increase in number of patients reaching their protein requirements. Regarding the energy intake, the number of patients reaching requirements was unchanged. Likewise, Stelten et al. showed significant improvements in protein intake when exchanging regular food with protein-dense food, and again no differences in energy intake were observed. The results of this study showed that an insufficient energy intake was a minor problem among the study participants. On average, patients ingested ≥ 75% of their total daily energy requirements. We have performed other studies in our hospital indicating the same results that insufficient energy intake is a minor problem compared to insufficient protein intake [16,18]. The protein intake is especially important in acutely ill and nutritional at risk population as protein intake may help ameliorate the effects of loss of muscle mass and sarcopenia when being old and link to bed rest [46,47]. Still, most studies finding a positive effect on these parameters involve healthy elderly and combine high protein intake, using either ONS or protein dense diet, with exercise [47,48]. Cheng et al. has performed a systematic literature review and meta-analysis investigating the effect of protein and amino acid supplementation on muscle strength and mass in malnourished and sarcopenia elderly. They found that supplementation may have a positive effect and the malnourished elderly were most likely to benefit from protein and amino acid supplementation without involving exercise. Thus, enriched high protein products seem to be a promising way for the malnourished or nutritional at-risk patient to maintain and maybe enhance muscle mass and strength, especially compared to using ONS, where wastage is high [26]. The Numami snacks were chosen 47% of times when offered, thus not all patients in IG did consume a Numami snack. The patients were asked to comment on the experience of eating the Numami snacks, and the comments were quite different and disparate ranging from “Where can I buy it? It is really good” to” No thanks to more. I really don’t like it!!”. Such statements highlight the fact that taste and preferences are very individual. Hence, nutritional care should be based on personalized desires and preferences instead of standard menus [49]. The taste of umami was carefully chosen as the basis of these products as umami has been shown to possess appetite enhancing effects [29]. Furthermore, we lack a salty and savory alternative, other than crisp, to the mostly sweet snacks that we have in our hospital today, thus umami seems the obvious choice as it increases the savory taste of food. It is the sodium salt of L-glutamate, Monosodium Glutamate (MSG), that provides the umami taste [29]. Furthermore, a review highlighted that adequate MSG fortification added to the diet in elderly might have potential to improve nutritional status and wellbeing by increasing palatability and appetite for food [39]. On the contrary, umami flavor has also been shown to decrease food intake of the subsequent meal and shown potential for increasing postingestive satiety [37,50]. This might explain why the total mean protein intake between groups was unchanged even though an increased protein intake from snacks was seen in IG compared to CG. However, this research area is still rather unexplored, and more evidence is needed to make any clear statements of how umami can optimize and regulate food intake [29]. The study is limited by having a small sample size. A small sample size could result in reduced probability to find any statistical significant differences between groups. The small sample size was partly a result of a high level of excluded food records due to a large number of

insufficiently completed records and many patients being discharged shortly after inclusion. The problem of insufficiently completed food records may be avoided if the researchers themselves had taken care of all tasks regarding the food record. However, the department nurses are all trained in filling out the food records to ensure consistency, thus the insufficient food records might indicate a pressure of business of the nurses due to economy matters with the unfortunate reductions in level of nurses in our hospital. Further, having a small sample size may preclude getting confident results. When the sample size is small, over- or under-reporting, or exclusion of a few patients' data may reverse the conclusion and the possibility of type two errors are high. Additionally, nutritional intake among patients is affected by many variables such as state of fatigue, their degree of appetite, feelings of nausea and pain, side effects from medications etc, and none of these were attempted to control [51,52]. Consequently, to state any clear improvement of energy and protein intake by ingestion of these products, a larger study including more patients and if possible controlling as many variables as possible e.g. by using standardized screening tools such as the brief fatigue inventory or The Simplified Nutritional Appetite Questionnaire (SNAQ) should be performed [53,54]. However, by using such screening tools, it is important to be aware that they are often only validated in certain patient groups, and they do often require further nutritional assessment than included in the tools [55]. Still, the tendency towards a higher nutritional intake, especially in the case of protein intake should be noted in this study. Even though the number of patients reaching their protein requirements increased in the study, the majority of patients still did not reach a sufficient intake according to the recommendations there by implying the necessity to continuously trying to improve the nutritional status among hospitalized patients in risk of malnutrition. Having a broad selection of adequate nutrient rich food items so the patients can choose based on their desires and preferences is one way of doing so.

Conclusion

Offering these novel umami tasting, protein-rich Numami snacks two times daily to hospitalize patients showed a significantly increased protein intake. More patients in IG reached their daily protein requirements compared with patients in the CG. However, the majority of patients did still not achieve the recommended intake of protein, which outlines the necessity to continuously try to improve nutritional intake by new initiatives. Protein fortifications of regular foods and new products seem to be promising in enhancing the protein intake among hospitalized patients.

Acknowledgment

This work was financially supported by Karl Pedersen og Hustru Industry fund. The authors would like to acknowledge Martin Jorgensen, Skaroe Is– Bio synergy for development of products and Erik T. Hansen (Danish Crown Ingredients) for delivering of hydrolyzed muscle beef protein powder. Subsequently, the authors will like to thanks Henrik Hojgaard Rasmussen (Aalborg University Hospital) for general supervision and research support. Finally, the authors will like to thanks the Head Nurses from the included departments for their cooperation and the occupational therapists at Aalborg University Hospital for keen guidance regarding product texture during product development.

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