

Abstract

42% of the children and adults in the US (aged 13-71) have lactose intolerance (Storhaug, 2017).

Lactose intolerance is due to the deficiency of an enzyme (i.e. lactase) that breaks down the milk sugar called lactose. Lactose is commonly found in milk, cheese, yogurt, etc.

The plant-based diet is becoming increasingly popular among Americans and rest of the world. The vegan diet excludes foods like meat, eggs, dairy, and any other product that comes from animals.

The researchers' dairy-free mac & cheese is intended to be a replacement for a traditional mac & cheese that contains milk and cheese. This recipe is ideal for those who are lactose intolerant or follow a vegan diet.



Introduction

A dairy-free diet with -- increased fiber and micronutrient content -- has clinically displayed many beneficial effects on various types of metabolic syndrome, such as lactose intolerance. People who are lactose intolerant commonly experience symptoms such as diarrhea, bloating, gas, nausea, abdominal pain, and stomach cramps.

Although a plant-based diet has many beneficial outcomes for health, for some, it can result into certain micronutrient deficiencies (especially vitamin B12). To identify B12 deficiency, some symptoms related to the condition include: anemia, tingling/numbness in the hands or legs, balance problems, and cognitive difficulties (NIH, 2020).

Traditional mac & cheese is substantially high in lactose and lower in vitamins/minerals. The researchers' modified recipe is intended to increase nutritional value while eliminating the lactose. To achieve a similar texture and consistency of the traditional mac and cheese, pureed butternut squash, cauliflower, onions, garlic, and veggie broth along with nutritional yeast can result in a thick and creamy "cheese" sauce.

Our modified mac & cheese recipe – high in Vitamin B12 and no lactose content – is developed to cater lactose intolerants and vegans.

The purpose of the study experiment was to develop a dairy-free mac & cheese product that mimicked that taste and texture of a traditional mac & cheese that contains milk and cheese.

Methods and Materials

The study experiment consisted of 7 participants, including the researchers and the instructor. The study consisted of 4 individual recipe testing sessions held every 2 weeks. The macronutrient & micronutrient value was determined using chronometer.

The study experiment was held at Fontbonne University in the Food Science Lab.

Our modified dairy-free mac and cheese recipe was inspired by a recipe found online, but the testers modified it to cater a broader audience. The recipe required a different approach than normal mac and cheese because the testers were not using real cheese to provide the thick, creamy taste and texture. Instead, the modified recipe consisted a mixture of vegetable broth, cauliflower, butternut squash, onions, garlic, nutritional yeast, and seasoning to make a sauce that resembled a cheese sauce

To determine sensory data, the subjects were provided sensory score cards that evaluated color, texture, smell, and taste. Sensory data was collected every recipe testing session and was taken in consideration for the future testing days to achieve the most acceptable end product. The scorecards used a hedonic scale and the higher mean number is associated with a more satisfactory product.

The Food Science lab has two kitchen areas in which the researchers tested the recipes. The main utensils used for the recipe include: baking pan, small boiling pot, knives, large saucepan, vitamix (food processor), spoons, baking sheet, wooden spoon, and gas stove top.

Results

On the recipe testing day #1, the researchers were unable to collect sensory scorecard data. There was also no control group since we did not have a boxed mac & cheese to compare the dairy-free recipe to. Despite these setbacks, verbal feedback showed that texture and taste needed improvements. All verbal feedback was considered and applied to the next recipe testing day.

On recipe testing day #2, the researchers recorded data using sensory scorecards. The boxed recipe scored a 1 for color, 2.83 for texture, 1.83 for smell, and 1.83 for taste, giving an overall score of 1.87. The dairy-free recipe scored a 2.83 for color, 3.66 for texture, 3 for smell, and 2.83 for taste, giving an overall score of 3.08.

On recipe testing day #3, the boxed recipe scored a 2 for color, 3.3 for texture, 2.8 for smell, and 1.5 for taste, giving an overall score of 2.4. The dairy-free recipe scored a 3.6 for color, 3.25 for texture, 2.8 for smell, and 2.75 for taste, giving an overall score of 3.1.

On recipe testing day #4, the boxed recipe scored 3.2 for color, 3 for texture, 2.8 for smell, and 1.9 for taste, giving an overall score of 2.75. The dairy-free recipe scored 3.6 for color, 3 for texture, 3 for smell, and 3.2 for taste, giving an overall score of 3.2.

Table 1: Boxed Mac & Cheese

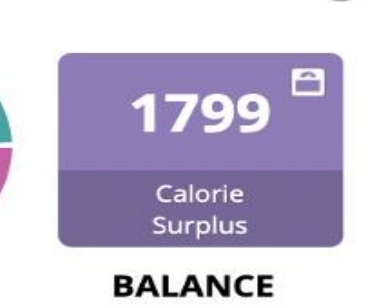
	Color	Texture	Smell	Taste
Week 2	1	2.83	1.83	1.83
Week 3	2	3.3	2.8	1.5
Week 4	3.2	3	2.8	1.9

Table 2: Dairy-Free Mac & Cheese

	Color	Texture	Smell	Taste
Week 2	2.83	3.66	3	2.83
Week 3	3.6	3.25	2.8	2.75
Week 4	3.6	3	3	3.2

Butternut Squash	4 cup, cubed	328
Onion, White, Yellow or Red, Raw	1 medium - 2 1/2" diameter	44
Cauliflower, Raw	4 cup, cut pieces	107
Banza, Pasta Shells Chickpea	8 x 2 oz	1520
Swanson Broth, Certified Organic Vegetable Broth	4 cup	47
Red Star, Nutritional Yeast	2 x 2 tbsp	120
Garlic, Fresh	4 clove	17.88
Daiya, Cheddar Style Shreds	4 x 1/4 cup	320
Bread Crumbs, Plain	0.5 cup, crumbled	213.31
Avocado Oil	2 tbsp	240.9

Calories Summary



Macronutrient Targets

Energy	2958 kcal / 1159 kcal (255%)
Protein	145.8 g / 72.4 g (201%)
Net Carbs	384.9 g / 115.9 g (332%)
Fat	81.5 g / 45.1 g (180%)

Discussion

Pureed butternut squash, cauliflower, onions, garlic, and veggie broth along with nutritional yeast can help achieve the "cheesy" sauce.

The modified mac & cheese recipe with no lactose content and higher B12 value can be enjoyed by many lactose intolerants and vegans.

Vegetables (i.e. butternut squash, cauliflower, onions, and garlic) present in the modified recipe boost the micronutrient value in comparison to traditional mac & cheese (control).

The experiment's limitations include the small sample size due to COVID-19 placing classroom size restrictions and the researchers' misplacing the sensory scorecards from the 1st testing session.

Future research and more recipe testing sessions are needed to achieve the most palatable and acceptable version of traditional mac & cheese.

Conclusions

The dairy-free mac & cheese recipe is an acceptable substitution for a traditional mac & cheese. The color, texture, smell, and taste are comparable to that of a boxed mac and cheese.

Peeling the butternut squash and adding adequate vegetable broth is important to control the texture of the "cheese" sauce.

Making dairy-free mac & cheese a part of one's regular diet can improve nutrient status and improve symptoms of lactose intolerance.

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