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Sensory Characteristics of Quinoa Chocolate Cake with Added Vegetables

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Abstract

It is recommended that adults should consume at least 2 cups of vegetables per day but about 2% males and 4% females consume this amount daily. It has been reported that increased consumption of vegetable/fruit reduce chronic diseases. Incorporating vegetables into dishes by chopping finely or pureeing is one way to consume the recommended daily amount. The purpose of this study was to increase vegetable intake by sneaking vegetables into foods/dishes that would not usually have them. Six types of chocolate cakes were made: traditional chocolate cake with 100% cake flour; cake with beets; cake with 50% cake flour/50% quinoa flour + beets, cake with zucchini; cake with 50% cake flour/50% quinoa flour + zucchini; cake with 100% quinoa flour. Sensory evaluation by 118 untrained panelists rated cakes using a 1-9 hedonic scale. ANOVA data for taste and moistness show significant difference ($p \leq 0.05$) between traditional cake and cake made with zucchini. Taste (score = 6.50) and moistness (score = 7.00) of cake made with zucchini were liked more than those of traditional cake (taste = 5.69; moistness = 5.75). Findings of this study could be used as a nutrition intervention tool in promoting vegetable intake among different groups, mainly those that may not consume vegetables.

Introduction

Report show that less than 9% of American eat the daily recommended 2-3 cups of vegetables **[1]**. Most Americans stated that they do not enjoy eating vegetables – which is the reason they do not eat vegetables. The best way to fit vegetables into the diet of someone who does not like vegetables is to hide them. The goal to achieve increased intake of vegetables is to avoid compromising the desirable flavor attributes.

Vegetables are nutrient dense food – i.e., vegetables have many nutrients with few calories. Researchers have hypothesized that most Americans do not enjoy vegetables because they have never gotten used to the flavor of vegetables. The acceptability of vegetables starts at early age and is influenced mostly by parents. The disposition of parents or peers to food greatly impacts children's response to foods **[2]**. It is recommended that infants and children should be offered healthier options repeatedly in an animated way to stimulate a positive response **[3]**.

Beetroot is a nutrient dense vegetable and low in calories (59 kcal per serving, 1 cup). It is an excellent source of folate (20% of daily value) and the root is a rich source of B-complex vitamins and minerals such as iron, manganese, magnesium, and copper **[4]**. This vegetable has a slightly earthy flavor which makes it difficult to mask in some recipes. However, chocolate can mask the earthy flavor that beetroot adds to recipe. Beetroot adds moisture and often makes a recipe sweeter when used. According to Gordon [5], when baking with beetroot, nutrients and vitamins are added to the recipe without sacrificing taste or texture.

Green cylindrical zucchini squash (courgette) is a low-calorie vegetable with 19 kcal per serving (1 cup). It has high water content and contains small edible seeds. It is a good source of potassium, vitamin C and contains moderate amount

of folate. Furthermore, it has moderate levels of B-complex vitamins (e.g., thiamin, riboflavin, and pyridoxine) and minerals such as iron, manganese, phosphorous and zinc **[6]**. A study by Marx et al. **[7]** studied how different flours and sweeteners effected cakes. It found that different types of flour affected the volume and crumb color of cakes. The most used flour is all-purpose flour with 10-13% protein content. Cake flour is used because it is slightly lighter and has a protein content of 8-9%. Cake flour is known as the "weakest flour on the shelf" **[7]**.

A variation of the cake uses quinoa flour as a supplement for the cake flour. Quinoa is a grain and is known as one of the most nutritious grain flours available. It has complete protein (i.e., contains all the essential amino acids) with protein content of 14-15%. Quinoa is a good source of protein, carbohydrate, essential minerals, and maltose. Its flour has a nutty and earthy flavor. It has favorable water and oil absorption capacity **[8]**. Quinoa flour can be substituted for up to half of all-purpose flour in recipes. If more than 50% quinoa flour is used in baking, the product becomes crumbly and falls apart very easily **[9]**. If a product needs to be gluten-free then half quinoa flour can be used with a gluten free binder flour. Föste et al. **[10]** reported that quinoa flour can completely replace wheat flour in some cake and cookie recipes.

The purpose of the study was to examine the effect of adding vegetables and quinoa flour on the sensory properties of chocolate cakes.

Study Hypotheses:

H0: Likeability of chocolate cake with or without vegetables and quinoa will be the same.

H1: Chocolate cakes with vegetables and quinoa will be liked more than cakes without them.

Materials and Methods

Chocolate cake (chococake) was prepared with slight modification **[11]**. The six types of chococake variations prepared are i) traditional (control; 100% cake flour), ii) traditional with beet, iii) 50% cake flour/50% quinoa flour (50/50) with beet, iv) traditional with Zucchini, v) 50/50 with zucchini, and vi) 100% quinoa flour. **(Table 1)** shows the cake variations used in the study. The sample ID is the randomly chosen 3-digit code used to identify each chococake for sensory evaluation as stated in the scorecard. Using randomly assigned code eliminates sample bias among panelists.

Sample ID	Chococake Types
345	Traditional chococake (control; 100% cake flour)
264	Traditional + beet
149	50/50 (50% cake flour/50% quinoa flour) + beet
257	Traditional + zucchini
316	50/50 (50% cake flour/50% quinoa flour) + zucchini
128	100% quinoa flour

Table 1: The chocolate cake variations.

Beetroots (beets)

Beets puree was prepared as described **[12]**. Clean beets to remove debris. Then cut beets into pieces/chunks and boil for about 30 min. Then blend beets into smooth puree with a food processor (Model: Cuisinart DFP-14BCNYC).

Green cylindrical zucchini

To prepare zucchini, peel skin off, then finely grate zucchini into a bowl.

Chococake Preparation

Chococakes were prepared as described **[13, 14]**. Cream shortening, eggs, sugar, vanilla, and salt for 15 mins (medium speed electric mixer). Then add beet puree in pertinent variations. Heat chocolate in microwave at 30 sec intervals until smooth. Stir chocolate into creamed mixture on medium speed for 1 min. Sift the baking soda twice with the flour. Add flour and milk in alternate amounts (in thirds) to the creamed mixture. Stir a total of 1 min following each addition and a total of 2 min following the last addition using medium speed on hand or bowl mixer. Then add in zucchini or beet into selected variations. Bake chococake in pan at 365°F for about 18-20 min. Test with toothpick for doneness. Then store cakes covered overnight on the counter.

Moisture Analysis

Moisture content of the cakes was determined in duplicates using standard oven drying method **[14]**. Exactly 2 g of each sample was weighed in labeled ceramic crucibles. The crucibles were placed in a moisture analysis oven at 100°C overnight. Then samples were taken out and placed in a desiccator to cool down. The samples were taken out and weighed until a constant weight was measured (i.e., the same final two measurements).

Sensory Evaluation

Chococake samples were cut the next morning to maintain freshness of samples. Cut cakes into 1.5 × 1.5-inch pieces and discard cake ends/crusts. Place cut cakes in aluminum foil containers and cover each layer with wax paper. Cover container until samples are ready to be served to panelists.

The taste panel was held in a designated sensory evaluation room. The cake samples were put in sampling plates labelled with 3-digit code numbers; and set up at the testing stations. Sensory evaluation was performed by 118 untrained panelists using hedonic scale of 1-9, where 1 = Dislike extremely and 9 = Like extremely. The panelists rated cake samples on scorecards for the attributes *taste, moistness, texture (mouthfeel), appearance*, and *crumb color* **(Table 2)**. Panelists read and signed a consent form prior to doing the taste testing.

Scorecard: After signing the consent form, please rate the cake samples using the ranking scale as follows:

9- Like Extremely
8- Like Very Much
7- Like Moderately
6- Like Slightly
5- Neither Like nor Dislike
4- Dislike Slightly
3- Dislike Moderately
2- Dislike Very Much
1- Dislike Extremely

Characteristics	345	264	149	257	316	128
Appearance						
Crumb Color						
Texture (Mouthfeel)						
Moistness						
Taste						

Table 2: Sensory Evaluation Scorecard for Chococakes.

Results and Discussion

Moisture Analysis

The chococake made with 100% quinoa flour had the least amount of moisture in it. Chococakes made with vegetables had high moisture content. Cakes made with beets retained more moisture than the traditional chococake (control; 100% cake flour). The zucchini cakes retained the most moisture among the six different chococakes **(Figure 1)**.

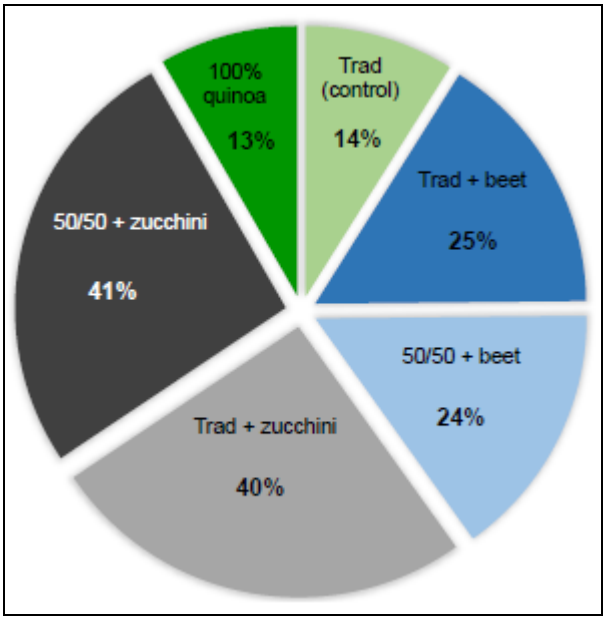

Figure 1: Percent moisture content of six chococake variations, i.e., traditional (control, 100% cake flour); traditional with beet; 50% cake flour/50% quinoa flour (50/50) with beet; traditional with zucchini; 50/50 with zucchini; and 100% quinoa flour.

Sensory Evaluation

The photos/images of chococake varieties used in the study are shown below:

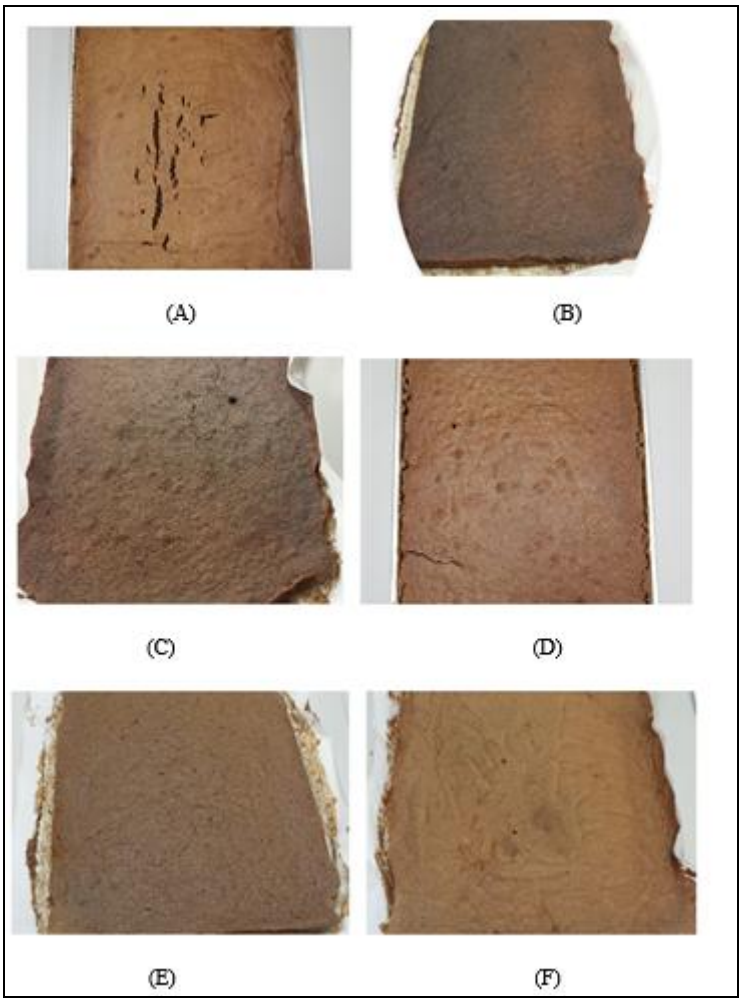

Figure 2: The images of chococake variations: A) Traditional (control, 100% cake flour); B) Traditional with beets; C) 50% cake flour/50% quinoa flour (50/50) with beets; D) Traditional with zucchini; E) 50/50 with zucchini; and F) 100% quinoa flour.

Overall Acceptability of Chocolate Cakes

The overall likeability scores of the chococake varieties by panelists are shown in **Figure 3**. The traditional chococake was compared to the other five chococakes using the General Linear Model (GLM) **[16, 17]**. The multivariate tests show that the ANOVA was significant (p=0.05). This indicates that panelists preferred at least one cake variation over the traditional chococake. The traditional chococake rated lower (5.82) than the other types of cake except the 100% quinoa cake which was rated 5.23. The traditional + zucchini chococake was rated highest (6.46) in overall acceptability **(Figure 3)**.

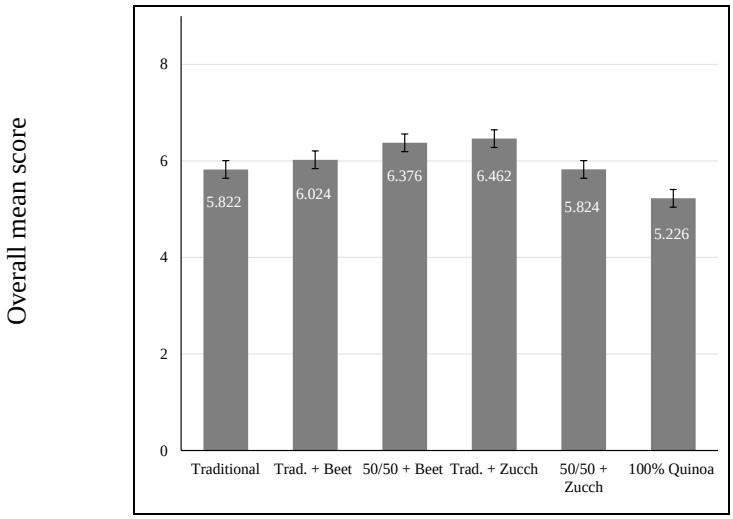

Figure 3: Overall acceptability scores of chococake varieties (Error bars: 95% CI).

GLM analysis of the taste and texture of chococake varieties show that the ANOVA was significant (p=0.05).

Chococake Types	Taste (Std Dev*)	Texture (Std Error*)	Moistness (Std Dev*)
Traditional chococake	5.69 (1.86)	6.19 (0.168)	5.75 (2.034)
Traditional + beet	5.01 (2.23)	6.35 (0.169)	6.63 (1.763)
50/50 + beet	5.66 (2.29)	6.66 (0.145)	6.85 (1.550)
Traditional + zucchini	6.56 (1.97)	6.84 (0.147)	6.97 (1.809)
50/50 + zucchini	5.80 (2.36)	6.06 (0.196)	6.55 (2.024)
100% Quinoa flour	5.50 (2.32)	5.29 (0.173)	4.78 (2.208)
*Std Dev and Std Error: 95% CI CI = Confidence Interval			

Table 3: Mean Scores for Taste, Texture, and Moistness.

The mean scores for the taste of chococakes followed the same pattern as the overall acceptability scores **(Figure 3)**. It is noteworthy that panelists rated traditional + zucchini chococake highest (6.56) in taste. The ANOVA is significant (p=0.05) showing that the taste of chococakes with vegetable purees were as well-liked as that of the traditional chococake which did not score highest in taste (5.69). The traditional + zucchini chococake was rated higher than the traditional chococake. This could be because zucchini is slightly sweet and does not have an overwhelming taste. In contrast, the traditional + beet was rated lower than the traditional cake. Some panelists stated that the traditional + beet cake tasted like dirt. This could be because beet is a root vegetable.

The mean scores for the texture (mouthfeel) of chococakes followed the same pattern as the scores for the taste **(Table 3)**. The texture of traditional + zucchini chococake was the most liked by the panelists (6.84). The data show that texture scores clustered more. There was a significant difference in mouthfeel between the traditional, 50/50 + beet, traditional + zucchini, and the 100% quinoa chococakes. The mouthfeel of the 50/50 + beet and that of the traditional + zucchini scored more than the mouthfeel of the traditional chococake. It can be deduced from this data that panelists liked the texture of chococakes that had vegetable purees more than the traditional chococake. The mouthfeel of 100% quinoa cake scored lower than that of the traditional (cake made with 100% cake flour).

Similar pattern was noted in how the panelists scored the moistness of the chococakes. The moistness of traditional + zucchini cake (6.97) was rated highest by panelists compared to the traditional chococake (5.75). Thus, it is evident that panelists liked the moistness of traditional + zucchini chococake more than the traditional cake. An explanation for this is that the beets and zucchini provided and retained water better than cakes without the vegetable purees.

However, the moistness of the traditional chococake scored higher than the moistness of the chococake made with 100% quinoa flour. The reason the moistness of cakes with 100% quinoa was disliked most by panelists is because quinoa flour is very dry and does not hold water well. When the vegetable purees were added to cake with quinoa flour, it compensated for the dryness that quinoa flour provided to the chococake.

The finding of this study is supported by the finding that quinoa bread crumb texture was slightly harsh when higher amount of quinoa flour is used **[18]**.

All the sensory scores show that chococakes with vegetable puree were rated better than or as good as the traditional chococake. The findings support the concept that adding vegetable puree did not lower the acceptability of the chococakes by panelists. Instead, the inclusion of vegetable purees in the chococakes significantly improved the sensory scores and preference of the chococakes. Since traditional + zucchini chococake was rated highest in all sensory characteristics (taste, texture, moistness, overall acceptability), a follow-up T-test analysis was performed to compare the sensory scores of traditional + zucchini chococake to those of traditional chococake.

Statistical Analysis Comparing Traditional + Zucchini and Traditional Chococakes

The repeated measures T-test analysis was a follow up to the overall findings of this study. The overall data show that panelists liked chococakes with vegetable purees as well as or better than the traditional chococake. The T-test analysis showed comparable scores between traditional chococake and chococakes with vegetable purees, f(1, 116) = 2.13, p=0.147, Eta = 0.018. However, it was noted that traditional chococake + zucchini was the highest scoring chococake overall **(Table 3; Figure 3)**. This is an important finding because one would expect that adding vegetables would reduce the preference for the chococakes with vegetable purees; instead, panelists liked chococakes with vegetables as well as the traditional cake. Moreover, the mean scores for the vegetable chococakes were often higher than scores for the traditional chococake.

It was evident from the sensory data that panelists did not dislike the chococake with vegetable options. The question becomes, do panelists prefer the traditional + zucchini chococake to the traditional chococake? An explanation is provided in **(tables 4-6)** below.

T-test Pairs Analysis: Traditional Paired with Traditional + Zucchini Chococakes (CI = 0.95).

Pair	Mean	N	Std. Deviation	Std. Error
Traditional chococake	5.822	117	1.2875	0.1190
Traditional + zucchini	6.462	117	1.3702	0.1267

Table 4: Paired Samples Statistics.

Pair	N	Correlation	Significance
Traditional chococake and Traditional + zucchini	117	0.253	0.006

Table 5: Paired Samples Correlations.

Pair	Mean Score	Std. Deviation	Std. Error Mean	95% CI of the difference	t	df	Sig. (2-tailed)
Traditional chococake - Traditional + zucchini	- 0.6393	1.6255	0.1503	- 0.9370 (lower) - 0.3417 (upper)	- 4.254	116	0.001

Table 6: Paired Samples Test - Paired Differences.

Data from paired samples T-test analysis **(Table 6)** show that traditional + zucchini chococake was significantly preferred to the traditional chococake; t(116) = -4.25, *p*=0.001. This shows that adding the vegetable purees in the chococakes did not cause the panelists to dislike the chococakes. The findings from this study show that the panelists preferred the traditional + zucchini chococakes to the traditional chococake in all sensory properties.

Conclusions

It has been reported that many Americans do not consume the recommended daily amount of vegetables. This covert inclusion concept could be used to showcase vegetables in a newer light; making vegetables more appealing/desirable than they used to be. Incorporating vegetables in chocolate cake (a food widely eaten by most people) could be a gateway to

increasing daily intake of vegetables in the diet – an important step to a healthier lifestyle.

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