



Full Length Research Paper

Validation of a food frequency questionnaire for soybeans consumption: Three statistical

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ABSTRACT

The use of soy protein products by the food industry has increased due to its relatively low cost, and mainly for its functional characteristics. The problem is that the consumer is unaware of soy presence in processed products and that it can be transgenic. To validate a food frequency questionnaire (FFQ), using three different statistical methodologies, to identify the consumption of food products that contain soy as an ingredient from a Collective Feeding menu. A FFQ was created according to the food products and preparations, which contained soy declared, as an ingredient, on the label, and which were identified on the menu of a Collective Feeding Unit. The consumers were split into two groups (G1 and G2) of fifty subjects in each. The consumption frequency was defined by six gradients of score's categories. Three methods were used for validation: Spearman, Bland&Altman and analysis of agreement-Kappa. The correlation coefficient of Spearman (r), achieved a value of 0.77 with variation of 0.6136 to 0.8642 ($p < 0.0001$). The coefficients of Cronbach were 0.88 and 0.79 for G1 and G2, respectively. According to Bland&Altman, it is possible to verify agreement in the responses of both groups, because the differences from the modal scores of frequency's consumption for products were distributed on the zero difference. The general Kappa value was 0.614. Conclusion: The FFQ was validated by the methods of Spearman's correlation, Bland&Altman and analysis of agreement-Kappa. These enabled us to draw the consumption profile of the interviewed group.

Keywords: Soybeans; Validation Studies; Food Frequency Questionnaires, Nutrition.

INTRODUCTION

The use of soy protein products by the food industry has been greatly increased due to its relatively low cost, and most importantly, functional characteristics. The ability that soy proteins have to improve certain properties such as food emulsion formation and stability depends on numerous factors: protein content, solubility, dispersibility, pH, temperature and processing methods (Xu et al., 2012).

Besides the improvement in protein-caloric quality, soy has contributed to the functional properties in food systems, such as the manufacture of beverages, burgers, sauces, soups, sausages and breads. Because being a

good foaming or aeration agent, soybeans are used functionally in the manufacture of many food products such as angel food cake, siph, soufflé, cake toppings, desserts and ice creams (Coulibaly et al., 2012; Shilpi and Kumar, 2013).

This soy widely used by the food industry can be transgenic due to the fact that Brazil would already be "surrounded" and "invaded" by genetically modified (GM) foods, present to a greater or lesser degree in American and Argentine industrial products imported by Brazil, besides of crops planted in the South, with GM seeds smuggled from Argentina (Araujo, 2001).

In Brazil, the use and trade of GM foods is regulated by CTNBio (National Technical Commission on Biosafety), a group created by Law 8974 of January 5, 1995 and restructured by Law 11.105 of March 24, 2005. According to Decree 4680 of April 24, 2003, it is provided to the public the right to information about the foods and food ingredients for human consumption or animal feed containing or produced from GM organisms (Brazil, 2003). The big issue is that the consumer is unaware of the presence of soy in many industrial products and that it can be transgenic soybeans.

Therefore, the purpose of the study was to validate a food frequency questionnaire, using three different statistical methodologies to identify the habit of consuming food products containing soy as an ingredient investigated from a menu used in Collective Feeding Collective service.

MATERIALS AND METHODS

Construction and application of socio-demographic and food frequency questionnaires

We have built a socio-demographic questionnaire according to the procedure proposed by the Brazilian Association of Research Companies (ABEP) (ABEP, 2003). The food frequency questionnaire was constructed using the information on food preparations and products containing soy as an ingredient declared in labels identified on the menu of a Food and Nutrition Unit, where we later applied the validated questionnaire. The consumption frequency was defined by the following gradient scoring categories: never (1), rarely (2) once a week (3), twice per week (4) three times per week (5), daily (6) (Willett, 1998).

Respondents, which were the employees of a commercial restaurant, were addressed in their workplace minutes before starting their workday and were asked to answer the questionnaire administered by a trained nutrition student. If doubts were raised, they were resolved immediately by the interviewer. The results from the questionnaires were tallied electronically with an Excel spreadsheet help.

Validation of the food frequency questionnaire

The validity of a measuring instrument can be defined as the extent to which the differences of the results obtained with this instrument reflect on the real differences between individuals, groups or situations regarding the characteristic that we seek to measure, or real differences in the same individual, group or situations from one occasion to another, and not constant or random errors (Selltiz and Deuts, 1974). It is said that a test

is valid, when it seems to measure everything the researcher have in mind.

In this study, the participants were divided into two groups (G1 and G2) containing 50 individuals on each. This division was made taking as an allocation criterion, the random number table (Spiegel, 1977). The sample included individuals of different ages, gender, educational level and socioeconomic status according to the procedure proposed by ABEP (2003).

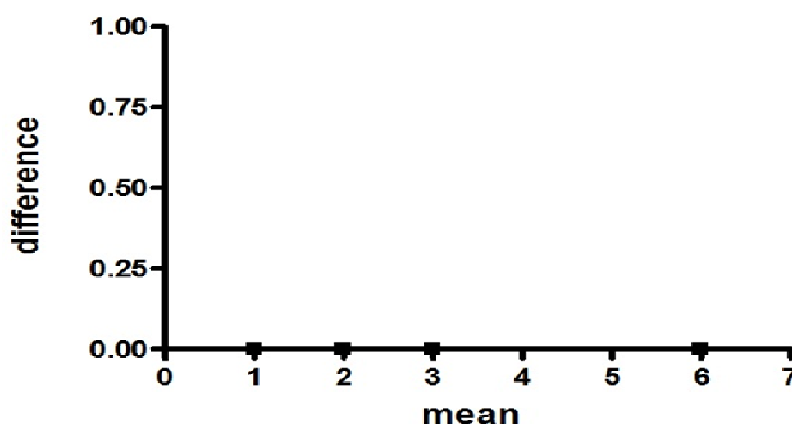
Researchers have experimentally validated some tests using correlation measures, which are a measure of association between the results obtained by its application in two samples with similar characteristics. Bland and Altman (1986) showed the impropriety of using correlation coefficient to show agreement between two methods. Given the above, three validation methods were used: the Spearman correlation, the method of Bland and Altman and Analysis of Agreement - Kappa.

Validation by the Spearman coefficient used two matrices constructed by the mode of consumption frequency scores which was obtained by each product evaluated by the respondents, since the consumption frequency was characterized by a categorical scale of agreement. We chose the Cronbach coefficient as a measure of the reliability of the scale (Behrens and Da Silva, 2004).

Bland and Altman (1986) proposed a graphical representation of the difference between the results obtained by both procedures against their average in a Cartesian graph, that is, the limits of agreements analysis. This study will confront the modal scores of Likert scale from the food frequency questionnaire of the two groups. The scores represent the intensity of consumption frequency proposed by Likert scale (Selltiz and Deuts, 1974). The graph allows investigating some possible relationship between the measurement errors and the true value. It is expected that the differences between the scores given by two groups are distributed as close as possible to the line corresponding to the average of the differences, if there is agreement between groups. When we cannot know the true value, the average of the two measures pairwise is the best estimative. There is no obvious relationship between the difference and the mean, under these circumstances we can summarize the lack of agreement calculating the estimated bias by the mean difference and standard deviation of the difference. In this method the limits of agreement are given by the mean of the difference minus two standard deviations and by the mean of the difference plus two standard deviations in the sample or its estimated values in the population, with confidence level of 95%. Analogously to the calculation of Spearman's coefficient, we used modal scores of consumption frequency of each product to the method procedures. The calculations were performed using the GraphPad Prism, version 4.0 (Motulsky, 2003).

Table 1. Analysis of agreement by Kappa between G1 and G2

	Never	Rarely	1 time per week	Daily
Kappa	0.659	0.556	-0.028	0.787
Kappa's value	P- < 0.001			
Confidence interval of 95% of Kappa	superior: 0.936 inferior: 0.382	superior: 0.83 inferior: 0.281	superior: 0.235 inferior: -0.291	superior: 1.0 inferior: 0.507

**Figure 1.** Diagram of the differences of the modal responses of G1 and G2 against its average proposed by Bland & Altman (1986).

Analysis of agreement by Kappa is used when the scales are categorical and when we compare the evaluation of two or more judges. The Kappa coefficient measures the degree of agreement, beyond what it would be expected by chance and is based on the number of concordant responses among the judges. A Kappa coefficient of zero indicates null agreement; if it is greater than zero, it indicates agreement greater than chance ($H_0: K=0$; $H_1: K > 0$). In this study each food product was judged by the two groups, using the categories of consumption frequency as categories of Kappa analysis.

Ethics Committee

This study was approved by the Ethics Committee on Research Involving Human Subjects of the Gama Filho University (protocol 009/JUL/2006), observing compliance with the ethical principles contained in the Declaration of Helsinki of the World Medical Association. We obtained the informed consent of each respondent. All participants were previously informed about the purpose of the work and the techniques which they would be submitted and we only included in the sample, those who have granted permission to be interviewed.

RESULTS

The scale was tested in a hundred individuals, which were potential consumers of the previously mentioned

products. Regarding gender, men and women were distributed almost equally. Respondents were concentrated in the age group of 18-40 years with education level of high school education (44%). Below this level of education, the distribution ranged from 18% for incomplete high school and 16% for elementary school education. The majority of respondents was in the social class C (57%), followed by the class D (22%) and B2 (17%). There were no individuals in social class A1 and E.

The first validation method, which was the Spearman correlation coefficient (r), reached a value of 0.77 with a range of 0.61 to 0.86 ($p < 0.0001$). Cronbach coefficients were 0.88 and 0.79 for G1 and G2 respectively, and it was appropriate since Mueller (1986) reports that a scale that has this coefficient equal or higher than 0.70 is a reliable measure for attitudes about the related object, since Mueller (1986) reports that a scale that has this ratio less than 0.70 is a reliable instrument to measure attitudes about the related object.

The confidence interval of the correlation coefficient (r) does not allow to visualize the difference between the answers given by participants in the two groups. To fill this gap, we used the diagram proposed by Bland and Altman (1986) which graphically represents this difference, in this case, the modal responses of the two groups.

In Figure 1, the total agreement can be verified, on the answers of the two groups, since the differences of

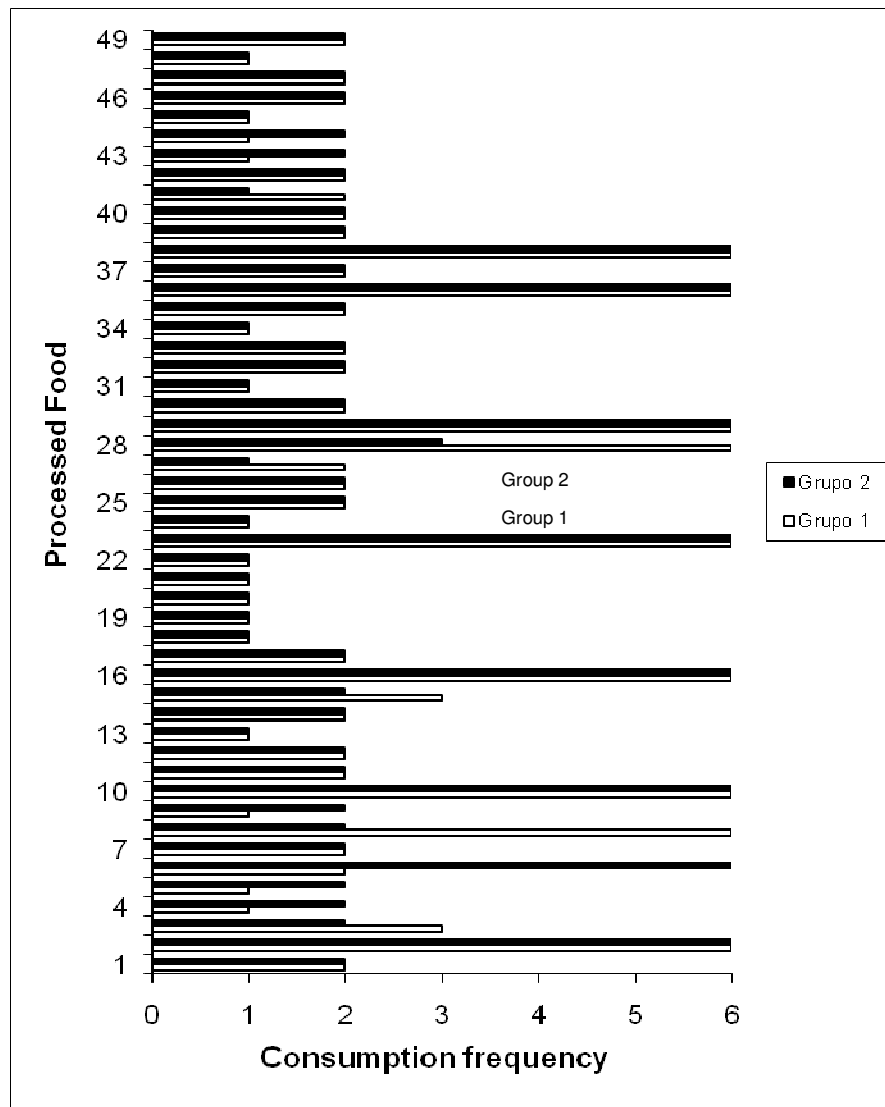


Figure 2. Consumption frequency of processed foods by G1 and G2

modal scores of consumption frequency for the products were distributed on the null difference. The limits of this difference, to the presented data, were null, given the significant agreement of consumption frequency between the two groups.

In the analysis of agreement by Kappa, the 49 products were evaluated by both groups of respondents, according to four frequencies of consumption: never (1), rarely (2), 1 time per week (3) and daily (4). Categories 2 and 3 times per week were excluded because they were not mentioned by the respondents. The results of the agreement measure of Kappa (Table 1) show that the category 1 time per week showed negative value, which has no reasonable interpretation. Of the three remaining categories the category of highest value was daily (0.787) demonstrating that in both groups there was agreement of frequency of daily consumption of products. The

overall kappa value 0.614 is considered like substantial agreement according to Landis and Koch (1997). Insert Table 1. Analysis of agreement by Kappa between G1 and G2.

The figure 2 presents the consumption habit profile considering product to product.

Figure 2 identifies that among the products, the ones consumed daily are: cookies, pasta, bread, mustard, vegetable cream, mayonnaise, canned peas and tomato pulp.

DISCUSSION

Bland and Altman (1986) and Delcourt et al. (1994) warn that a high correlation coefficient does not mean that two measurements agree, i.e., the correlation measure does

Table 2 . Consumption frequency of processed foods by G1 and G2.

1.Corn starch	11.Pastry dough	21.Soy sauce	31. Soy yogurt	41.French Fries (Frozen)
2.Cookies	12.Pasta for lasagna	22.Mustard	32. Cream cheese	42. Straw potatoes
3. Cake	13. Dough for rolling	23. Seasoning paste	33. Fruit juice (box)	43.Industrialized cake
4.Oatmeal	14. Pancake dough	24.Torrone	34. Soy milk fruit Juice	44. Processed farofa
5.Cornmeal	15. Pizza dough	25.Japanese peanuts	35. Peas (canned)	45. Salad dressing
6.Cassava flour	16.Bread	26.Whipped cream	36.Cocoa beverage	46. Microwave popcorn
7. Breadcrumbs	17.Ketchup	27. Vegetable cream	37.Corn (canned)	47.Pudding
8. Wheat flour	18. Garlic sauce	28. Mayonnaise	38.Tomato pulp	48. Instant mashed potatoes
9. wholemeal	19.Pepper sauce	29. Margarine	39. Sardines (canned)	49.Pies
10.Pasta	20. English sauce	30. Powdered milk	40.Chicken strips	

not indicate how much the scores deviate from the line of 45°. In this study, the Spearman correlation coefficient reached 0.77. The authors also explain that correlation measures the strength of association between two variables, but the agreement between them.

Another widely used procedure for checking statistical equality between the obtained measures from two series of measure is the paired t test. In this case a high value of variability could negatively influence the test results masking the findings (Martelli Filho et al, 2005). In this sense, an association measure or hypothesis test of differences in means would not be indicated to verify the agreement between assessments. Thus, Bland and Altman (1986) proposed a graphical method that is capable of displaying the difference between measures of assessments, pointing errors, which reflect the disagreement, besides of allowing the use of samples with at least 10 pairs of measurement, which may be free in refers to its distribution profile. In the present study, we used 49 pairs of measures representing products containing soy in their formulation and there was significant agreement in the reporting of the respondents (in both groups) probably because they are employees of a network of commercial restaurants with standardized menus besides of working hours that extends for nine hours. This situation causes first round employees to have breakfast and lunch and the second round employees to have snack and dinner, i.e., they enjoy the same standard food offered by the company.

Observing Table 1, we see that the categories of consumption frequency extremes, such as daily and never were those who had higher values according to the Kappa measure. The category of consumption frequency rarely loses strength of agreement and once a week is not even interpretable.

The study findings lead us to believe that the respondents have difficulty in perceiving minutiae about

the consumption frequency such as one, two and three times a week. In this study the respondents mostly belong to social class C, which this products may not be part of their habit. The education issue did not influence the choice of products, as a major constraint to the variability of a diet is purchasing power, which in this population is low.

CONCLUSION

The results indicate that the food frequency questionnaire to identify the habit of consuming of soy food products whose ingredients are declared on the label was validated by the methods of Spearman correlation, Bland and Altman and Analysis of Agreement - Kappa as well as it was possible to draw a consumption profile of the group interviewed.

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Appendix 1 – Socio-demographic questionnaire and Food frequency questionnaire**Personal data**

Age:	Sexo:	Escolaridade:
<input type="checkbox"/> 18 - 25 years	<input type="checkbox"/> Female	<input type="checkbox"/> Incomplete elementary school
<input type="checkbox"/> 26 - 40 years	<input type="checkbox"/> Male	<input type="checkbox"/> Elementary school education
<input type="checkbox"/> 41 years ou more		<input type="checkbox"/> Incomplete high school
		<input type="checkbox"/> High school education
		<input type="checkbox"/> Graduate student
		<input type="checkbox"/> Graduation completed
		<input type="checkbox"/> Postgraduation

Socio-economic data

Items	Quantity
Color television	
Radio	
Bathroom	
Automobile	
Regular housemaid	
Vacuum cleaner	
Wash machine	
VCR and / or DVD	
Refrigerator	
Freezer	

Head of household education level

- Unlettered / Incomplete Middle school
 Middle school education / Incomplete elementary school
 Elementary school education / Incomplete high school
 High school education / Graduate student
 Graduation completed

Socio-demographic questionnaire and Food frequency questionnaire continues

Products	Daily	1 time per week	2 times per week	3 times per week	Rarely	Never
Corn starch						
Cookies						
Cake						
Oatmeal						
Cornmeal (grits)						
Cassava flour						
Breadcrumbs						
Wheat flour						
Wholemeal (Kebab)						
Pasta						
Pastry dough						
Pasta for lasagne						
Dough for rolling						
Pancake dough						
Pizza dough						
Bread						
Ketchup						
Garlic sauce						
Pepper sauce						
English sauce						
Soy sauce						
Mustard						
Seasoning paste						
Torrone						
Japanese peanuts						
Whipped cream						
Vegetable cream						
Mayonnaise						
Margarine						
Powdered milk						
Soy yogurt						
Cream cheese						
Fruit juice (box)						
Soy milk fruit Juice						
Peas (canned)						
Cocoa beverage						
Corn (canned)						
Tomato pulp						
Sardines (canned)						
Chicken strips						
French fries (frozen)						
Straw potatoes						
Industrialized cake						
Processed farofa						
Salad dressing						
Microwave popcorn						
Pudding						
Instant mashed potatoes						
Pies						