Sensory analysis of beans (*Phaseolus vulgaris*)

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The methodology of sensory profiling constitutes the basis of a descriptive quantitative analysis, defining a product with the minimum number of words and with maximum efficiency, using a precise tasting sheet, which can be reproduced and is understood by all. In this work, the texture profiling for different bean varieties that are characteristic of the Spanish market was carried out. Optimum conditions for samples and a tasting card were established, and a panel was trained. The texture profile results show significant differences amongst varieties and even amongst different origins for the same variety.
Keywords. Kidney beans, soaking, cooking, panel, texture profile.

Analyse sensorielle du haricot commun (*Phaseolus vulgaris*). La méthodologie d'un profil sensoriel constitue la base d'une analyse descriptive quantitative, définissant un produit avec un nombre minimum de mots et avec un maximum d'efficacité, utilisant un formulaire précis du goût, lequel peut être reproduit et compris par tous. Dans ce travail, le profil de la texture pour différentes variétés de haricot commun caractéristiques du marché espagnol a été réalisé. Des conditions optimales pour les échantillons et une carte d'appréciation du goût ont été établies; un groupe d'évaluateurs a été formé. Les résultats du profil textural des haricots ont montré des différences significatives non seulement parmi les variétés mais aussi entre les échantillons d'une même variété provenant de différents sites d'origine.
Mots-clés. Haricot commun, trempage, cuisson, jury, profil de texture.

1. INTRODUCTION

The objective is to define the sensory quality of the beans, establishing a protocol for the preparation of samples and a tasting sheet for the texture profile. The first methodological aspect is the formation of a tasting panel, the organization of sessions, the pre-selection of descriptive factors and the final list. It ends with a tasting sheet with the descriptive factors, in order of perception, and with a structured scale (Bourne, 1972; Blair, 1978; Meilgaard *et al*, 1987). The second methodological aspect is the training of the judges, with an evaluation of agreed criteria and the consistency and the ability of the team to reproduce results as well as their sensory evaluation of the varieties, by explaining the differences that exist between them (Amerine *et al*, 1965; Drake, 1989; Mioche, Touraille, 1990).

2. MATERIAL

The study was undertaken using commercial varieties (A, B, C) that were representative of the national market of white beans. All samples were acquired in the market, being of the same brand and packaged in the same year, in one kilogram package sizes.

3. METHODS AND RESULTS

3.1. Preparation of the sample

The cooking and preparation conditions of the samples will be selected, recreating the conditions of consumption (Rousset-Akrim, *et al* 1995). The soaking, cooking and preparation of the samples were studied.

For soaking, samples of 500 g were used with 3 litres of low mineralized water at 14ºC for 10 hours.

For cooking, a thick based, 5 litre stainless steel saucepan was used. The heating system employed was a 1.500 W electric hotplate. During the cooking process, the same water was used as for the soaking and the sample remained covered by water all the time. In order to determine the quantity of salt used, comparative tasting in pairs with a forced decision was carried out to state a preference between two samples containing different quantities of salt (0, 3, 5 and 7 g/500 g sample) and using 16 assessors. The absence of salt was considered negative, whereas with 5 g of salt per 500 g sample, the minimum number of responses necessary for a level of significance of 5% was obtained.

The temperature and quantity of the studied sample was established in the presentation. The service temperature was identified by carrying out tests in pairs,

using the same sample but at different temperatures (90, 70 and 50ºC), asking the 16 assessors to state their preference by forced decision. A temperature of 70ºC was decisive in order to obtain a level of significance of 1%. The sample quantity presented was 40 g of cooked beans per taster (Sanz, 1997).

3.2. Elaboration of sensory profile

Results obtained from discussions among the judges of the tasting panel and from consultations with industrialists and consumers revealed that the texture and visual appearance are fundamental for sensorial analysis.

The recruitment and selection of the panel judges was carried out among SIA ("Servicio de Investigación, Desarrollo y Tecnologia Agraria") personnel, by means of an oral survey using the following selection criteria: motivation (all volunteers), rejection (those who did not like beans were eliminated) and availability (attendance at all sessions).

Training was undertaken to ensure reproducibility, applying UNE rules at all times. The first training phase consisted of sensory physiology training, the differences between inter and intra-individuals and the instructions for the tasting sessions. In the second phase, texture profile techniques were studied, evaluating the capacity to describe different food products (apples, fried potatoes, cheeses, chocolates, chewing gums, etc.). The third phase involved working with different samples of pulses with various culinary preparation techniques. The training sessions continued throughout six weeks, with three two-hour sessions per week, between 11 and 13 o'clock. The maximum number of samples tasted per session was four.

The assessors were selected through a method of sequential analysis using a triangular test (Burr *et al*, 1968; Sidel *et al*, 1981; Powers *et al*, 1984). This method makes it possible to draw a graph with two straight parallel lines which divide a plane in an area of acceptance, rejection or indecision, each panel judge being situated in one of these areas, depending on his/her ability to discriminate. For aptitude criteria for the tasters, the values $p_0 = 0,45$ and $p_1 = 0,70$, were taken, expressed as a proportion of the correct results, admitting that the probability of rejecting an acceptable taster or admitting an unacceptable taster would be 0,05.

The selection of the assessors was made from the 16 assessors employed in the cooking and preparation tests. Results obtained from 10 tasting sessions were displayed on a sequential analysis graph, which permitted the acceptance of 12 assessors, while 4 assessors were eliminated having remained in the zone of indecision.

The experimental plan was developed in accordance with a model of complete balanced blocks with repetitions (Gacula *et al*, 1974; Costell, 1983; Galt, Mac Leod, 1983).

The choice of texture descriptions was made by the twelve panel judges selected to taste the different types of beans, using a pre-established list of terms and producing some new ones. They selected the following terms:
– visual appearance (general appearance of the grain, complete or broken and the presence of loose skin),
– surface characteristics (sensation produced by the skin on contact with the tongue and palate, whether rough, smooth or wrinkled),
– behaviour of product towards deformation once inside the mouth (toughness of skin and albumen, using the terms hard, tender, smooth, soft or firm),
– structural characteristics (terms relating to the albumen such as buttery, floury, grainy or lumpy) and
– other perceptions during mastication (terms of residual sensation like astringency or stickiness).

All terms that were cited more than once by a person and more than once for a product were included in the list. The twelve judges subsequently tasted the same samples of pulses, but assigning a value between 1 and 5, in accordance with the intensity of the sensation perceived. In order to eliminate the descriptive factors, a decreasing classification was undertaken, using the geometric mean of the sum of the frequencies of the citations and the sum of the accumulated intensities (Civille, 1973; Cornell, Knapp, 1974).

In order to prepare the tasting sheet, five tasting sessions were carried out. Using the scores given by each of the assessors, a descriptive factor/product matrix was drawn up, from which a Principal Components Analysis was obtained. In the Principal Components Analysis, axis I shows a 28% variability and is made up of the descriptive factors WS (wholeness of skin), WG (wholeness of grain), B (butteriness) and TS (toughness of skin). Axis II shows a 24% variability and is made up of the descriptive factors A (astringency), G (graininess), S (stickiness) and F (flouriness). Axis III shows a variability of 21% and is made up of SS (skin surface). A lexicon was produced with a definition of each of the terms used, employing the definitions of AENOR (UNE 87).

Several terms are involved in the definition of the descriptive factors: whole grain (complete grain without any breakage), smooth surface grain (grain with no presence of wrinkles on skin), hardness of skin or albumen (resistance when chewing), buttery albumen (sensation of soft and smooth contact that lines the inside of the mouth), grainy albumen (sensation of small hard grains in the mouth), floury albumen (sensation of flour in the mouth). The tasting

sheet was made up with a bi-polar scale using a five-point structure (1 = broken, smooth, soft, nothing and 5 = whole, wrinkled, hard, very).

Agreement of criteria was examined by presenting samples of different beans except one, which was repeated in all the sessions. In total five repetitions of the same sample were carried out. For each of the descriptive factors on the tasting card, a variance analysis was undertaken for one factor (assessors) at different levels (repetitions). The existence of significant differences indicates that there are assessors who disagree with themselves and one must therefore study the effect that excluding them from the group will have. The identification of the assessors who disagree with themselves is made using Duncan's test: once they have been identified, the variance analysis is repeated.

In order to know the consistency of the group of assessors, the reproduction of issued verdicts was analysed by evaluating one sample of beans in five tasting sessions, through a variance analysis for one factor (sample) at different levels (repetitions) for each of the descriptive factors on the tasting card.

Subsequently, the tasting card was used and the team trained to establish the differences between the different types of beans. The experimental design was taken from a complete balanced block with four repetitions. Using the obtained scores a variance analysis was carried out, in which three factors were studied, corresponding to the descriptive factors on the testing card (F1 varieties, F2 assessors and F3 repetitions).

The differences between the varieties refer to the descriptive factors SS, TS, S and F. Significant differences were not recorded between the repetitions, or between the tasters, which confirm the suitability of the training for the tasting group and the protocol employed for the preparation of samples. The differences found between varieties were conclusive since the product/taster interrelation (F1/F2) is not significant in any of the cases. Variety A is characterized by its smooth and hard skin, hard and unfloury albumen. Variety C is characterized by its wrinkled and soft skin, soft and very floury albumen. Variety B is characterized by having values that are intermediate to those of varieties A and C. **Table 1** shows an example of Duncan's test results to discriminate between varieties.

The tasting sheet was also used to establish the differences between various origin sites of the same bean variety. In twelve sessions, the 12 trained assessors used the tasting sheet following the design model of complete balanced blocks with repetitions. With the scores obtained a variance analysis was carried out, in which three factors and their interrelation, corresponding to the variables with the

Table 1. Example of results of the Duncan's test to discriminate between varieties — *Exemple de résultats du test de Duncan pour établir une distinction entre variétés.*

Descriptive factors	Averages	Varieties
Skin surface	2,2a	C
	1,9b	B
	1,2c	A
Toughness of skin	3,4a	A
	3,0ab	B
	2,2b	C
Stickiness	2,5a	A
	1,8b	B
	1,4c	C
Flouriness	2,6a	C
	2,2b	B
	1,9c	A

descriptive factors for each tasting (F1 site of origin, F2 assessors and F3 repetitions), were studied. The selected samples belong to the Canellini variety, which was chosen for its high consumption level, using two sites of origin (Argentina and Spain).

The differences between the sites of origin were only established for the descriptive factors TS, S and G (**Table 2**). It can be stated that Canellini beans of Spanish origin have a soft skin, with a hard and grainy albumen, whereas Canellini beans of Argentinian origin have a hard skin with a soft and not very grainy albumen.

Table 2. Example of results of the Duncan's test to discriminate between Canellini bean origin sites — *Exemple de résultats du test de Duncan pour établir une distinction entre sites d'origine pour la variété de haricot grain Canellini.*

Descriptive Factors	Averages	Identification
Toughness of skin	3,3a	Argentina
	2,5b	Spain
Stickiness	1,8a	Spain
	1,0b	Argentina
Graininess	2,1a	Spain
	1,4b	Argentina

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