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A pilot study on sensory evaluation of commercial yogurt products by Italian pupils from middle school†

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Abstract: This article reports a pilot experiment conducted on the STEM teaching (Science, Technology, Engineering and Mathematics) in the context of orientation teaching in young pupils take on the role of "young researchers". Twenty-six pupils participated to this research and 18 of them evaluated 20 commercial yogurts (banana, vanilla, strawberry, and plain yogurt). They assessed acidity, sweetness, odour, texture, taste, and overall acceptability through a 5-point scale. Data were analyzed through non-parametric test, box-whisker plots, and Principal Component Analysis. Statistic pointed out that for teenagers the overall acceptability was directly related to sweetness (0.695), odour (0.587), and taste (0.861), and indirectly related to acidity (-0.517); in addition, non-parametric test shows a high variability inside the dataset, with a not-normal distribution of sensory scores.

Keywords: middle school; yogurt; sensory analyses; orientation teaching; pedagogical innovation

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1. Introduction

Consumer interest in functional foods is growing significantly in the food market landscape, and consumers are becoming increasingly health-conscious while increasing the demand for healthier foods [1]. Yogurt consumption, in particular, offers the consumer a wide range of choices in terms of availability, variety, as well as tastes and flavours, and it has increased around the world because of its nutritional value, therapeutic effects, and functional properties [2].

Several studies have confirmed that yogurt has positive effects on human health and improves it reducing the risk of disease [3,4]. In fact, it has observed that yogurt consumption helps to treat diseases including obesity, allergies, intestinal tract inflammation, colon cancer, cardiovascular disease, and *Helicobacter pylori* infection [5-10].

Furthermore, yogurt is easily digested because milk protein, fat, and lactose components undergo partial hydrolysis during fermentation, and this make the product extremely accessible to children from an early age. This is also because it has high nutritional value and is a rich source of carbohydrates, protein, fat, vitamins, calcium and phosphorus [11].

The consumer is becoming greater careful when choosing the products to buy, and wholesomeness, safety and functionality are the main parameters of choice. The flavour is a key factor for food stuff acceptability by consumers [12], and available evidence suggest a marked preference for the fruity yogurts[13]. Introduction of various fruit-flavoured yogurts has significantly contributed to the consumption of yogurt from all ages [12].

Nowadays yogurt enters the homes of almost all Italians. In fact, since 2010, 99% of Italian families buy yogurt during the year with an average of once every 12 days. This

figure, already present in the literature [14], was confirmed by a recent survey carried out in early 2023 [15].

Younger consumers and adolescents, regardless of gender, therefore, consider yogurt one of the foods including choose to stop hunger mid-morning or in the afternoon, associating it, for example, with coffee or crackers. They are considered heavy consumers of yogurt and fermented milks, and they make up an important segment of consumers, improvingly updated by advertising messages, attracted by fashions and in line with current trends. They are also particularly attentive to the quality and safety of the products, innovative, informed, and cultured, of international culture, very active, outgoing, attentive to emotions and feelings, able to decide of one's life [16].

Although there are many studies relating to the positive factors registered by the consumption of yogurt in relation to the health and well-being of children and adolescents [5-10], little is known about their tastes in relation to this type of products and the choices' purchase of functional foods and yogurt, in particular.

On the basis of these considerations, scientific research was designed within a project on the teaching of STEM (Science, Technology, Engineering and Mathematics).

This pilot study was conducted in a synergistic way between the DAFNE Department of the University of Foggia (Department of the Science of Agriculture, Food, Natural Resources and Engineering) and Comprehensive Institute "Foscolo-Gabelli", an Italian middle school of Foggia (Italy), and it aims at studying and increasing the degree of knowledge of the pupils on functional foods and clarifying the point of view of adolescents on the consumption of yogurt by outlining the choices and motivations underlying the purchase of the product by means of a sensory evaluation on commercial yogurts in terms of acidity, sweetness, odour, texture and taste and overall acceptability.

This is certainly the first study about pedagogy and orientation teaching in which such young pupils take on the role of "young researchers" by conducting the entire scientific study alongside industry professionals in order to evaluate the development of specific skills in the technical-scientific field.

2. Materials and Methods

2.1. Pupils, framework and planning process.

This study was conducted by 26 pupils attending the third classes of an Italian middle school (Comprehensive Institute "Foscolo-Gabelli", Foggia, Italy); their Science and Technology teachers act as supervisors.

The pupils, on the basis of their personal attitudes towards mathematical-scientific disciplines, freely chose to participate in "Laboratorio di Math 2", a course of 30 hours on Science and Technology, which was a part of a grant from National Operational Program (Italian PON) of the Ministry of Education, and Merit, (project 10.2.2A-FSEPON-PU-2021-125). The focus of the project was on STEM teaching (Science, Technology, Engineering and Mathematics) and the project was supervised by DAFNE Department of the University of Foggia.

The course was divided in two parts: i) preliminary training on functional foods (lectures); ii) panel test and sensory evaluation on commercial yogurts.

2.2. Preliminary training on functional foods

In the first part of the project, all 26 pupils, after an initial assessment on the basic skills and the prerequisites in Science and Math necessary to face the subsequent course, attended a preliminary training course organised in 10 lessons of three hours each.

In particular, the lessons were structured to provide specific information and broaden knowledge about functional foods, yogurt, its composition and functional properties, sensory analysis of yogurt and how to set up a panel test, how to collect, analyze and represent statistical data. Furthermore, laboratory lessons on the microbiological

analysis of yogurt, on the preparation of a panel test on yogurt and fermented milks, and on how to write a scientific paper in English were planned.

All the training course was performed by their Science and Technology teachers and by professors of DAFNE Department of University of Foggia, using the CLIL methodology (Content and Language Integrated Learning).

2.3. Panel test and sensory evaluation on commercial yogurt

2.3.1. Preliminary survey

In the second part of the project, all the pupils, on the bases of the knowledge and skills acquired during the initial training course, conducted a survey to find out which yogurt brands were present and best sold on the local market. The 26 pupils were divided into two groups: group A (8 pupils) and group B (18 pupils).

2.3.2. Samples

The pupils of group A identified 20 samples of yogurt, referring to 7 brands and 4 flavours, to be subjected to a panel test aimed at evaluating the sensory properties of the samples in terms of acidity, sweetness, odour, texture, taste, and overall acceptability.

The commercial sample of yogurt were obtained from retail stores in the local (Foggia, Italy) marketplace. Because of the relatively high number of samples evaluated, it was impossible to obtain commercial samples that bore the same expiration (sell-by) dates. However, yogurt samples were chosen from the store shelves that exhibited the latest expiration date possible. All containers (purchased as single serving containers) of each yogurt brand were from the same lot. All yogurt samples were obtained no more than 3 days prior to sensory evaluation.

The samples were labelled as follows: A, banana brand 1; B, banana brand 2; C, banana brand 3; D, banana brand 4; E, banana brand 5; F, banana brand 6; G, strawberry brand 3; H, strawberry brand 1; I, strawberry brand 5; L, strawberry brand 4; M, strawberry brand 2; N, strawberry brand 7; O, vanilla brand 5; P, vanilla brand 4; Q, vanilla brand 7; R, vanilla brand 3; S, plain yogurt brand 7; T, plain yogurt brand 1; U, plain yogurt brand 4; V, plain yogurt brand 2.

2.3.3. Descriptive and Consumer Panel

Sensory evaluation was conducted within the Science Laboratory at Comprehensive Institute "Foscolo-Gabelli" (Foggia, Italy) by the pupils of group B through an internal protocol of the laboratory of Predictive Microbiology of the University of Foggia. The samples were placed on special counters consisting of separate stations and spring water was provided for rinsing between samples. The serving temperatures was 3.3°C, and the samples size was 40 ml of yogurt served in 60 ml odourless plastic cups. The panellist rated all samples with two replications. Samples were presented in two sets, each consisting of either three or four samples.

Panellists rested between sets to avoid or minimize fatigue; they evaluated acidity, sweetness, odour, texture, taste, and overall acceptability through a 5-point scale and answered two questions about their personal yogurt consumption frequency and whether or not they had ever bought the samples submitted for analysis.

2.3.3. Statistic

Data were analyzed through Kruskal-Wallis, chi square and multiple comparison's z-test, and graphically reported as box-whisker plots. In addition, multiple comparison amongst sensory scores (acidity, odour, taste, sweetness, texture, and overall acceptability) were performed. Statistic was done through the software Statistica for Windows (Statsoft, Tulsa, Okhla.).

3. Results and Discussion

3.1. Sensory scores

As a first step, sensory predictors were analyzed through non-parametric statistic as a function of brands; scores were quite variable, and figure 1 shows overall acceptability. The brands S and U showed significantly lower acceptability than other brands, and both were plain yogurts. However, these lower sensory scores were not related to acidity, as these brands were not perceived as more acid than the others. Thus, the leading hypothesis was that the scores was affected by taste.

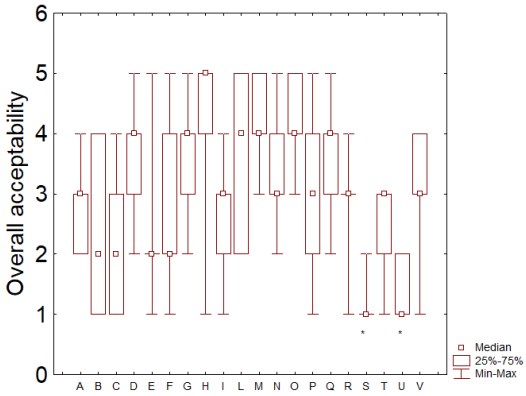

Figure 1. This is a figure. Schemes follow the same formatting. The symbol "*" indicates a significant difference (multiple z comparison test, P<0.05).

Therefore, as a second step scores were analyzed using as predictors not the brands, but the taste (banana, strawberry, vanilla, and plain yogurt). Figure 2 shows the output for overall acceptability and taste. As expected, the overall acceptability was strongly influenced by taste, as the yogurt with the highest scores were vanilla and strawberry-flavoured ones, while the less-preferred were plain-yogurt samples.

This result was influenced by taste, which followed the same trends.

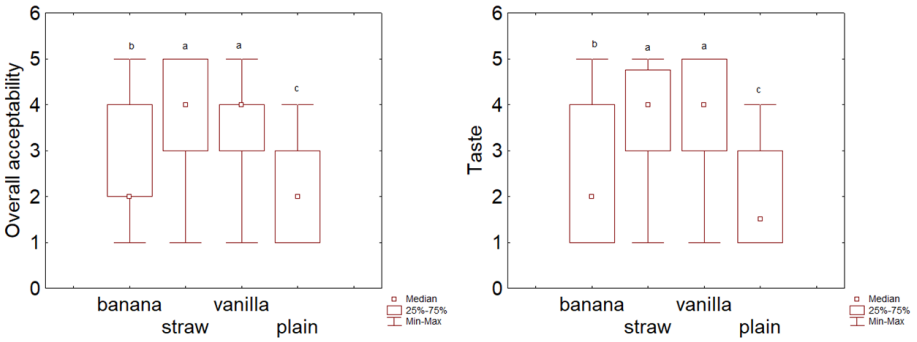

Figure 2. Sensory predictors analyzed as a function of yogurt taste; the letters indicate significant differences (multiple z comparison test, P<0.05).

3.2. Multiple comparison

As a final step, data were analyzed through a multiple comparison procedure to assess if some of the sensory predictors affected the overall acceptability of yogurts, independently from the taste; the outputs are in table 1. Statistic pointed out that for teenagers the overall acceptability was directly related to sweetness (0.695), odour (0.587), and taste (0.861), and indirectly related to acidity (-0.517), while negative taste vs acidity (-0.564), and positive taste vs sweetness correlations (0.688) were perceived.

Table 1. Multiple comparisons amongst predictors of sensory scores.

	Acidity	**Sweetness**	**Odour**	**Taste**	**Texture**	**Overall acceptability**
Acidity	1.000	-0.564	-0.253	-0.475	-0.143	-0.517
Sweetness	-0.564	1.000	0.459	0.688	0.280	0.695
Odour	-0.253	0.459	1.000	0.591	0.391	0.587
Taste	-0.475	0.688	0.591	1.000	0.255	0.861
Texture	-0.143	0.280	0.391	0.255	1.000	0.345
Overall acceptability	-0.517	0.695	0.587	0.861	0.345	1.000

3.3. A reflection on STEM approach

Finding teaching methods that capture pupils' attention is certainly the challenge that schools face today to guarantee each student significant learning, capable of anchoring new knowledge to existing ones, and to achieve educational success.

STEM teaching is continuously searching innovative methodologies to achieve this goal and to offer immediate answers to the pupils who are at the center of the educational process; in fact, it is very complicated to transmit content that requires increasingly higher and specific skills to deal with increasingly complex knowledge [17].

Bringing such young pupils closer to scientific research, for example by making them touch the challenges that food microbiology and technology researchers face every day in the field, was the winning key in this experimentation to increase motivation and interest, approaching the discipline with a degree of maturity certainly higher than what happened with the traditional study.

Furthermore, considering that the choice to participate in this course was free, the pupils developed their own talents starting from their personal aptitudes, significantly strengthening specific skills and competences, acquiring a higher degree of knowledge than that is required in the degree of school they attend. This, in addition to obtaining positive results on the possession of knowledge and skills, was fundamental in structuring a critical thinking such as to favor a more conscious orientation process towards choices related to future study courses and professional choices.

All this has favored an increase in well-being at school, confirming that working on one's talents and on one's natural predispositions by structuring innovative educational paths that stimulate the interest of pupils is the winning key to developing happiness as a life skill at school [17].

4. Conclusion

This research offers an important contribution to elucidate the point of view of adolescents, providing a significant contribution to studies on consumer knowledge in the functional food market. Furthermore, it provides an innovative help to the field of pedagogy and orientation teaching, bringing young pupils closer to scientific research from an early age and strengthening specific skills with a view to a more effective structuring of process of pedagogical orientation towards increasingly aware future choices.

From a technical perspective, the results showed that pupils' overall acceptability of yogurt was affected by sweetness, odour, and taste and negatively by acidity.

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Conflicts of Interest: The authors declare no conflict of interest.

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