A study of sensory and nutritional quality of virgin olive oil. Presentation of a European project of research

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SUMMARY

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The purpose of this paper is to present, in a synthesis, the objectives and means of the FLAIR project on olive oil quality (FLAIR proposal N.º 89041, contract N° AGRF - CT91 - 0046).

Comments are reported on the scientific assumptions and practical problems that have motivated this research. The participants are also presented with their roles and tasks in the project.

KEY-WORDS: FLAIR Project - Nutritional quality - Sensory quality - Virgin olive oil.

1. THE OBJECTIVES OF THE PROJECT

The initial set-up of research objectives

The objectives of the project approved by the participants and EC authorities were initially defined as follows:

a) *Sensory quality*
- Set-up of a standard terminology describing the sensory profile of virgin olive oil;
- Standardization of sensory analysis of olive oil including sampling, tasting procedure and the statistical processing of sensory data;
- Sensory profiles of virgin olive oil differing in origin, technology and shelf-life.

b) *Consumer preference*
- Identification of critical sensory parameters for consumer preference;
- Evaluation, in sensory terms, of differences in preference between a traditional (Italian) and a potential (English) consumer of virgin olive oil;
- Identification of physical and physico-chemical parameters related to sensory quality and preference.

c) *Shelf-life*
- Shelf-life evaluation, and possible modelling, in terms of sensory profile variation;

- Identification of sensory parameters related to the freshness and stability of virgin olive oil.

d) *Nutritional quality*
- Experimental evidence and quantitative evaluation of *"in vivo"* antioxidant activity of virgin olive oil; set-up of a routinary analytical index related to the above property.

The establishment of *Good Manufacturing Practice* guidelines for virgin olive oil production was also considered as a possible result of the technological work and a valuable by-product of the project.

A rationale behind the objectives

The above objectives were initially defined as the result of a critical reasoning about current knowledge and practice in the virgin olive oil field. Any survey of olive oil scientific and technical literature shows an overwhelming priority of chemical and analytical studies. The major aim of traditional research in virgin olive oil is to define analytical composition and to set-up analytical methods in order to detect natural components or contaminants. Olive oil experts are chemists, almost by definition. Even legislators, who are concerned with olive oil regulation, use the concepts and the language of chemical experts.

The consequences of this approach were considered unsatisfactory from three main points of view:

a) The sensory quality of virgin olive oil has not been investigated thoroughly. And yet, consumer preferences are mainly determined by the sensory characteristics of virgin olive oil. The sensory methods currently used in virgin olive oil evaluation (the so-called COI test) do not appear to be sound and reliable. They give conflicting results and are the source of commercial disputes.

When this project was first discussed, the partners unanimously decided that the most important research objective was to study the sensory quality of virgin olive oil and to set-up appropriate, standardized evaluation methods.

b) References concerning nutritional studies of virgin olive oil are also relatively scarce. On the other hand, epidemiological studies on Mediterranean population and reasonable hypotheses suggest that virgin olive oil may have distinctive healthy effects. Therefore, the study of *"in vivo"* antioxidant activity of olive oil was included in the project.

c) As a consequence of the traditional, chemical oriented approach, quality control of virgin olive oil is generally identified with product analysis.
We know that this approach is inadequate and must be integrated by a process control approach. Therefore, it was decided that the definition of Good Manufacturing Practices in virgin olive oil production should be set up as one of the objectives of the project.

As researches were carried out throughout the three years of activity, it was clearer and clearer that the above objectives were essentially methodological in nature. We were not working principally on oils, olives or technology, but rather on methods. From the discussion among the partners, it became clear that the major aim of the project was not to establish virgin olive oil classifications, but rather to set up methods and standards to classify virgin olive oil and to evaluate processes.

2. MEANS USED TO ACHIEVE THE OBJECTIVES

Oil samples

The first point considered by the participants was that of virgin olive oil samples. They should meet the following requirements:
- be undoubtedly "virgin" according to legislation; i.e.: extracted from fresh olives by mechanical and physical means only.
- be representative of varieties and origin, degree of ripeness and of the most common technological processes.
- be produced, packed, stored and transferred to the partners following a standardized procedure, so that they could be used by all the partners in a similar state of preservation.

The critical importance of this point suggested that virgin olive oil samples could not be taken from the market shelves, but should be produced and distributed under controlled conditions. Therefore, three partners were charged with such a task, namely Biagini, Instituto de la Grasa and Eleourgiki as representative of Italian, Spanish and Greek producers, respectively.

Production of virgin olive oil samples was carried out under the responsibility of the above partners, in the same places and following the same processes all the three years.

A systematic monitoring and registration of the production conditions has been carried out. Among others, a young French engineer with a three year fellowship in the frame of the FLAIR project, was charged of supervising the whole production and distribution procedure (Sophie Chemin, FLAIR N.º 89041, N° B/900838).

The following table summarizes the characteristics of the virgin olive oil samples used in this project.

Table I
Virgin Olive Oil samples used in this project

CODE	COUNTRY	VARIETY	DEGREE OF RIPENESS	EXTRACTION TECHNOLOGY
G.01.01.CE	Greece	Coroneiki	Unripe	Centrifugation
G.01.02.CE	Greece	Coroneiki	Normal	Centrifugation
G.01.03.CE	Greece	Coroneiki	Over-ripe	Centrifugation
G.01.02.PE	Greece	Coroneiki	Normal	Percolation
G.02.02.CE	Greece	Tzunnati	Normal	Centrifugation
I.03.01.CE	Italy	Moraiolo	Unripe	Centrifugation
I.03.02.CE	Italy	Moraiolo	Normal	Centrifugation
I.03.03.CE	Italy	Moraiolo	Over-ripe	Centrifugation
I.03.02.pE	Italy	Moraiolo	Normal	Expression
I.04.02.CE	Italy	Frantoio	Normal	Centrifugation
S.05.01.CE	Spain	Picual	Unripe	Centrifugation
S.05.02.CE	Spain	Picual	Normal	Centrifugation
S.05.03.CE	Spain	Picual	Over-ripe	Centrifugation
S.06.01.CE	Spain	Arbequina	Unripe	Centrifugation
S.06.02.CE	Spain	Arbequina	Normal	Centrifugation
S.06.03.CE	Spain	Arbequina	Over-ripe	Centrifugation

It is clear, from the number of samples and from the fact that the experiments were repeated for three years, that results were expected to give useful informations about the influence of variety and origin, degree of ripeness and process technology.

Statistical methods

In addition to chemical, physical and sensory methods, the use of advanced statistical methods is a peculiarity of this research. The following methods have been adopted for the analysis of results:

METHOD	PURPOSE
Analysis of Variance Student-Newman-Keuls significance test	Evaluate the effects of the degree of ripeness, extraction method, variety of olives and year of harvest on the sensory and chemical characteristic of samples
Principal Component Analysis, PCA Generalized Procustes Analysis, GPA	Differentiating and grouping of samples in the sensory space of appearance, mounthfeel, smell, taste and aftertaste. Identifying sensory or chemical descriptors that characterize the different samples.
Partial Least Square Analysis Correlation Coefficient	Finding correlations between sensory and instrumental (chemical, physical) data.
Cluster Analysis	Grouping of samples and terms used by different panels for expressing sensory attributes.
Preference Mapping, PREFMAP	Identifying a preference vector, or an ideal point, for each consumer onto a multivariate plot produced from the trained panel results. Grouping of consumer preferences.

People and Organizations

It was suggested from the beginning the need of mixing up abilities, experiences and interests. This would guarantee a built-in variety of points of view and, therefore, a more significant consensus on the conclusions.

The people and organizations involved in the research could assure to the project:

a) A variety of abilities:
  • Sensory analysis experts
  • Chemical analysis experts
  • Nutritionists
  • Food technologists
  • Statistics experts
  • Psychologists or consumer behaviour experts

b) A variety of scientific experiences and particularly:
  • People and organizations with a wide experience on olive oil study

  • People and organizations with a wide experience in sensory and statistical methodologies
  • People with a traditional relationship with virgin olive oil as consumers
  • People without any significant experience as virgin olive oil consumers

c) A variety of interests:
  • Private commercial companies
  • Private industrial companies
  • Public research institutions and universities
  • Private consulting companies

Very few FLAIR projects have such a complex mix of participants, belonging to five European Countries, namely Greece, Italy, The Netherlands, Spain and United Kingdom. The following table summarizes the partners and their tasks in the project.

Table II
List of organizations and experimental tasks.

COUNTRY	ORGANIZATION	TASK
GREECE	ELEOURGIKI Private commercial and industrial company	Selection, production and distribution of Greek samples C.O.I test Sensory study Statistical analysis of sensory data Relating sensory data and technology/raw material data Standardization and set up of GMP for virgin olive oil production
ITALY	BIAGINI FSD Private consulting company	Selection, production and distribution of Italian samples Sensory study Preference study on Italian consumers Statistical analysis of sensory data Relating sensory data and technology/raw material data
ITALY	STAZIONE OLI E GRASSI Publich research and consulting organization	C.O.I test Reference composition data of all samples Statistical analysis of sensory data Relating sensory data and technology/raw material data
ITALY	UNIVERSITY OF MILAN	Nutritional studies Reference composition data of all samples Statistical analysis of nutritional results Relating nutritional and technology/raw material data Standardization and set up of GMP for virgin olive oil production
THE NETHERLANDS	UNILEVER Private commercial and industrial company	Sensory study Shelf-life study Statistical analysis of sensory data Relating sensory, shelf-life and technology/raw material data
SPAIN	INSTITUTO DE LA GRASA Publich research and consulting organization	Selection, production and distribution of Spanish samples C.O.I test Statistical analysis of sensory data Relating all data Standardization and set up of GMP for virgin olive oil production
UNITED KINGDOM	CFDRA Private consulting company	Sensory study Preference study on English consumers Statistical analysis of all data, relating all data