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Botanical quality controls and uses of *Origanum vulgare* L. products and their impact on food security in the province of Jujuy - Argentina

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***Abstract*—In Argentina, a nation committed to prioritizing food quality, there is a pressing necessity to fortify quality control systems and establish stringent standards ensuring food safety. This study aims to scrutinize commercial samples of Origanum vulgare L. in the province of Jujuy, Argentine Republic, with the objective of assessing their authenticity and overall quality. Both macroscopic and microscopic techniques were employed to analyze composition and verify identity. Simultaneously, a thorough examination of product labels was conducted to ensure compliance with food regulations. Ethnographic techniques, including merchant interviews, were utilized to gather comprehensive insights. The findings reveal considerable variability in the composition of "oregano" samples, with instances of foreign elements such as stones and dust detected in some cases. Microscopic identification unequivocally confirmed the presence of contaminating elements. Notably, the majority of industrial products adhered to labeling standards, while a mere 10% of artisanal samples achieved similar compliance. The study also unveiled diverse culinary and medicinal applications for the examined oregano samples. These discoveries underscore the imperative for heightened oversight to guarantee the quality and purity of oregano products. The correlation between microscopic results and previous studies bolsters the reliability of this analytical approach. In conclusion, the study emphasizes the paramount importance of instituting policies and programs that advance food security. The proposed methodology emerges as an effective means to enhance quality control in the marketing of plant products in the province.**

Keywords*— *authenticity, composition, labeling, regulations, uses.

I. INTRODUCTION

The significance of food security encompasses various dimensions and consequences [9, 30], particularly in the imperative to ensure food safety, preventing contamination, adulteration, or fraud. These hazards not only deceive consumers but also pose risks of foodborne diseases (FBD), a connection underscored by authors such as Grace et al. [21], emphasizing the pivotal role of food safety in reducing the global burden of diseases caused by foodborne pathogens.

Argentina, with its robust agricultural and livestock tradition, places a paramount emphasis on food quality for public health and access to safe, nutritious food. Diverse authors stress the necessity to enhance quality control systems, implement good production practices, train involved stakeholders, and adopt standards as crucial elements to ensure food safety [2, 4, 28, 29, 36].

In the pursuit of these guidelines, "oregano" emerges as a paradigm illustrating the meticulous management required for food production and distribution to preserve its properties and benefits. Implementing good practices in oregano cultivation becomes imperative to maintain its quality profile [8].

The Argentine Food Code (A.F.C) stipulates in art. 1226 that, during commercialization, up to a maximum of 2% of plant material from other species and 3% of the stem of the same species are permissible. Previous studies have identified diagnostic features for oregano leaves, including specific types of hairs and glandular structures [20, 26].

A comprehensive study of commercial oregano products in the province of Jujuy addressed aspects such as microbiological quality, authenticity through DNA sequencing, and analyses using chromatography, spectrometry, infrared spectroscopy, and chemical composition profiling. These advanced techniques, though swift, may not always be economical and require diverse inputs [3, 5, 10, 23, 27, 32, 35, 43].

Botanical quality controls, exemplified by the micrographic method, play a pivotal role in evaluating and authenticating plant-derived products [37], [19, 17, 18, 38]. This method proves to be a useful, quick, and cost-effective tool for certifying the quality of foods for human consumption made with plant species [16, 17, 18]. Its applicability allows for

certification of safe foods, a critical aspect often overlooked in routine food testing in responsible organizations' laboratories [41, 33, 31, 13, 1].

The condition of genuineness, ascertained through micrographic techniques, directly correlates with the information stated on labels, as per the Argentine Food Code (A.F.C) [40]. This research underscores the importance of evaluating oregano quality in Jujuy, with a focus on ensuring food safety and consumer satisfaction.

The objective of this study was to apply diagnostic features of leaves and young stems of Origanum vulgare L., "oregano," using micrographic techniques for botanical quality control of commercial samples. The analysis also included scrutinizing label information concerning compliance with the Argentine Food Code (A.F.C) and exploring culinary qualities through interviews with merchants.

II. Material And Method

A. Materials

The acquisitions were made in the city of San Salvador de Jujuy through both formal commercial channels (supermarkets, pantries, and mini markets) and informal channels (regional fairs sponsored by the Municipality and street stalls). These acquisitions constitute the Ethnobotanical Collection of the Group of Ethnobiology and Applied Micrography (GEMA), comprising the Sampler of Ethnobotanical and Micrographic Materials, denoted as CEM-GEMA.

All Origanum vulgare L. samples were procured by the primary author, Gimenez, from the Dr. Manuel Belgrano Department in the City of San Salvador de Jujuy, and are now housed within the aforementioned Collection. To prevent redundant information, the acronym is initially indicated, followed by corresponding numbers based on business characteristics.

Informal businesses, CEM-GEMA 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100;

Formal shops, CEM-GEMA 102, 103, 104, 105, 106, 107, 08, 109, 110, 111, 112.

B. Methods

The methodologies were meticulously developed in sequential stages:

I. The species in its packaging

Macroscopic Analysis: Components of all samples were separated, photographed with a Kodak AF 5X Optical Aspheric Lens digital camera, weighed on a Digital Kitchen Scale HD-806 balance, and percentages of elements (leaves, branches, foreign inorganic and organic matter) were determined.

Microscopic Analysis: Micrographic method based on the observation of anatomical characters and cellular metabolism products proposed as identifiers of leaves and young stems. Various histological and histochemical techniques were applied following D'Ambrogio de Argüeso [7], [12, 22].

Microscopy:

a. Histological Techniques: For dehydrated products like condiments, portions were randomly taken from different areas of the container through quartering to obtain a representative sample. The slight dissociation technique involved treating the material with a 5% NaOH aqueous solution, boiling for 5 minutes, washing with distilled water, and observing with an optical microscope [12]. Observations were recorded using photomicrographs, with ten repetitions for each sample to detect diagnostic characters.

b. Histochemical Techniques: Lipid characterization was performed on the sample, and lipids reacted with Sudan III, turning red. Excess reagent was subsequently removed with 70% alcohol.

Microscopic observation and photographic recording.

The photomicrographs were taken with a Canon compact digital photography camera, model Powershot A640, attached to an Arcano trinocular microscope model Xsz 107 Bnt Led Light.

II. The labels on the containers.

Observation and comparison of food product labeling were conducted in accordance with current regulations (Chapter V of the A.F.C. - Standards for the Labeling and Advertising of Foods). Compliance with mandatory requirements, such as food name, list of ingredients, net contents, origin identification, lot identification, date of duration and preparation, and instructions for use, when applicable, was verified [23].

III. Inquiring about the uses recommended by merchants.

Ethnographic strategies, including open interviews, were incorporated during sample acquisition to understand the usual and preferred culinary uses of the spice as relayed by merchants.

III. Results

A. Macroscopic analyzes

Macroscopic observations elucidating the product composition revealed varying percentages concerning the presence of leaves, bracts, flowers, as well as organic and inorganic matter (stones, dust, residues). Leaves were observed (Fig. 1) in proportions ranging from 6.45% to 54%, while bracts and flowers exhibited variations from 3.22% to 74%. The organic matter spanned from 42.1% to 77%, and the inorganic matter exhibited values from 0% to 75% (Table I). These findings underscore the diversity in the composition of oregano products, emphasizing the imperative for producers to ensure the quality and purity of the product through adherence to Good Manufacturing Practices (GMP) during procurement.

B. Micrographic Analysis

In the realm of microscopic scrutiny, the validation of diagnostic foliar features of oregano facilitated the affirmation of its identification. Notably, the presence of long, rough, multicellular tecting hairs (Figs. 2. B. C) and lamiaceous hairs with a short single-celled foot and secretory head arranged in a rosette shape (Figs. 2. D. E) distinguished themselves. Another

significant facet of the analysis involved glandular hairs, existing in the examined samples, characterized by a short single-celled foot and a single-celled globose head (Figs. 2. D. F). These elements assume a pivotal role in determining the species.

However, certain samples exhibited extraneous components in alignment with macroscopic observations. These manifested as elongated cells with discernible features consistent with wheat bran (Figs. 3. A. B. C. D), as well as unicellular tecting hairs (Fig. 3. E), fungal fruiting bodies (dictiospora), and remnants of unidentified tissue (Fig. 3. F).

TABLE I. MACROSCOPIC ANALYSIS OF "OREGANO" SAMPLES

Sample	Leaves	Bracts and Flowers	Organic material	Matt. Inorganic (stones, dust, waste)
N°	%	%	%	%
1	*6,45*	3,22	58,06	32,25
2	*15*	5	77	3
3	*21,05*	26,31	42,1	10,5
4	*54*	46	0	0
5	*11,11*	11,61	44	33
6	*0*	0	25	75
7	*8,33*	16,67	50	25
8	*10*	10	40	40
9	*5*	5	50	40
10	*5*	10	40	60
11	*25*	58,3	0	16,67
12	*10*	10	30	50
13	*20*	60	0	30
14	*14*	18	68	0
15	*35*	65	0	0
16	*33*	67	0	0
17	*26*	74	0	0
18	*44*	18	38	0
19	*38*	62	0	0
20	*26*	21	53	0
21	*42*	58	0	0
22	*35*	43	22	0
23	*28*	72	0	0
24	*39*	46	15	0

Fig. 1. A. Leaves of *O. vulgare*. B. Bracts and flowers. C. D. E. Colored wheat bran. F. Stones

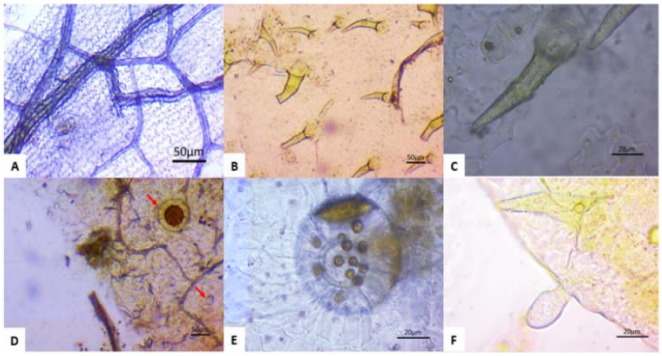

Fig. 2. A. Epidermal cells, vascular bundles. B. C. Multicellular tecting hairs. D. Lamiaceous hair (pl), glandular hair (gl), unicellular foot and unicellular head, vascular bundles and parenchyma. E. Lamiaceous hair. F. Glandular hair with single-celled foot and single-celled head.

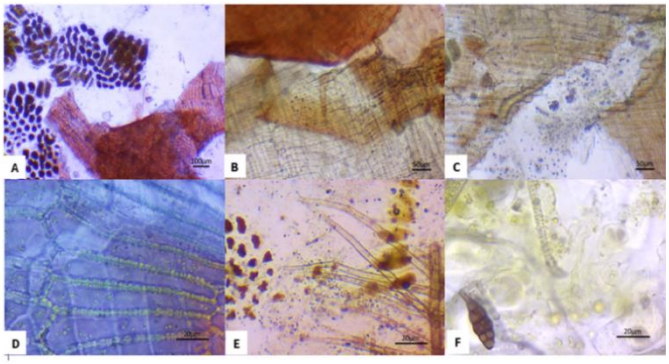

Fig. 3. A. B. C. Tissue foreign to the species under study. D. Elongated cells with punctate cell walls. E. Unicellular protective hairs. F. Parenchyma and dictiospore.

B. Analysis of labeling according to the Argentine Food Code

Concerning the prevailing regulations, the sales name corresponding to the acquired samples was predominantly present in industrial products, but only in 10% of the artisanal sales samples. Furthermore, solely products of industrial origin exhibited origin identification, lot identification, and expiration date, as illustrated in Figure 4.

In terms of food preparation information, the majority of artisanal sales samples lacked such details, a characteristic shared by two industrial sales samples. Container presentation varied, with artisanal ones featuring heat sealing and knots, while the remaining were presented in sealed containers.

Notably, it was observed that a seller procured a product of a specific brand in bulk and subsequently divided it into small plastic bags, yet failed to provide any details corresponding to the original packaging.

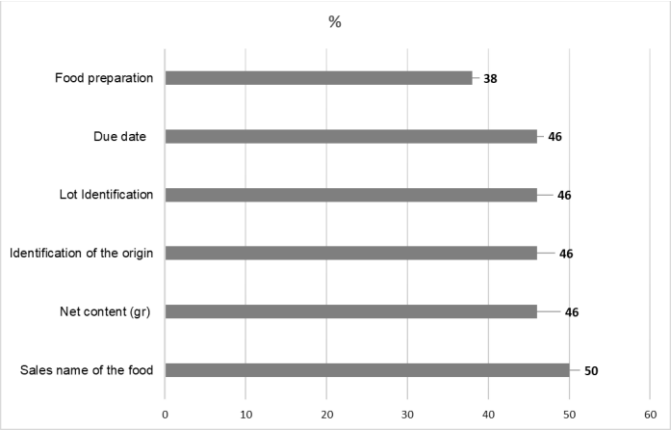

Fig. 4. Labels according to the F.A.C. (% compliance with regulations).

C. Culinary and medicinal uses revealed by traders

The uses of oregano were further investigated and documented in Table II. It was observed that the majority of street stall or fair vendors primarily acknowledged its application in seasoning various foods such as pizzas, soups, stews, sauces, salads, and flavored breads.

Interestingly, one vendor suggested potential culinary uses in liquor stores, particularly during festivities like "Pachamama" when the earth is ceremonially nourished, or during "Patronal Festivals". Conversely, some vendors mentioned its medicinal usage as a "tea" (infusion) to alleviate coughs or phlegm. In certain instances, historical references were made to its use as an abortifacient.

Moreover, it's noteworthy that certain samples of industrial origin provided specific instructions for use and suggestions to enhance flavor in different foods on their labels.

TABLE II. USES OF OREGANO PROVIDED BY SELLERS AND LABELED

VULGAR NAME	APPLICATIONS	%
ORÉGANO	Season	63
	Soups, stews, etc.	13
	Spirits	4
	Flavored breads	4
	Tea for cough or phlegm	13
	Abortive	8
	Instructions and foods to add	38

IV. DISCUSSION

The macroscopic findings of this study unveiled substantial variability in the composition of the oregano samples, carrying significant implications in light of the regulations stipulated by the Argentine Food Code [6]. The presence of fluctuating percentages of leaves, bracts, flowers, and both organic and inorganic matter indicates a lack of uniformity, inevitably impacting the quality and purity of the evaluated products. These discrepancies can be attributed to various factors, including origin, processing, and packaging methods employed in the sale of oregano.

In this context, it is noteworthy that the Argentine Food Code [6] establishes specific limits for the commercialization of the species, such as a maximum of 2% foreign plant material and 3% stems. The obtained results reveal the presence of inorganic matter, such as stones and dust, signifying non-compliance with the purity standards mandated by current legislation in Argentina.

Hence, these findings underscore the imperative of strengthening surveillance and control throughout the species' supply chain, encompassing both artisanal and industrial products, to ensure adherence to defined quality and purity standards. This not only aids in mitigating the risks of food-related illnesses but also aligns with the broader goal of upholding food safety, as underscored in preceding research [21], [28], [4], [29].

The correlation of microscopic results with prior research [39], [40] emphasizes the consistency and reliability of this investigative approach, highlighting the significance of micrographic evaluation and its direct implications on the quality and authenticity of the analyzed product.

Microscopic analysis not only verifies the presence of characteristic elements of oregano proposed in previous studies [26], [20] but also discloses the existence of external elements affecting product quality, aligning with botanical quality control research conducted by various authors [42], [34], [18], [19], [31], [13], [1]. These findings support the swift and accurate certification of safety by control bodies, as demonstrated in analogous research on infusions and candied fruits [35], [17]. Adequate labeling is essential for routine quality controls, ensuring compliance with all aspects established by current legislation to guarantee consumer protection.

The observed non-compliance regarding product fractionation out of the consumer's view, as stipulated in article 18 of the Food Code [9], underscores the necessity of incorporating relevant information in labeling, an aspect neglected in oregano products.

The diverse uses identified by merchants in the province, both as a seasoning for foods and liquors and for medicinal purposes, align with previous research highlighting its versatility [25], [11]. This information must be included in works like the present one, reflecting a sustained social demand over time and emphasizing the importance of quality controls in preserving consumer health [1], [21].

These results emphasize the imperative to implement more stringent quality control measures, as advocated by other researchers [2], [4], [28], [29], [37], ensuring that food products, specifically oregano, comply with the standards established by current regulations [6], thereby providing security to the consumer through both formal and informal marketing channels. Addressing the mentioned good practices

[8] is vital, covering a broad spectrum of dimensions and effectively tackling foodborne diseases [9], [30]. Furthermore, countering economic risks associated with food adulterations, in line with the study on ethnic spices and ingredients in the city of Kolhapur, India [43], is crucial. Consumers need to be adequately informed about these requirements and encouraged to seek products complying with established regulations. These investigations underscore the global and multifaceted nature of food security as a priority concern [30], [31].

V. CONCLUSION

Food quality plays a pivotal role in ensuring food security in Argentina. To achieve this objective, the implementation of robust quality control systems and the advocacy for good manufacturing practices emerge as indispensable factors to elevate quality standards and mitigate potential public health risks.

In a context where macroscopic analysis revealed that 46% of the samples comply with the standards of the Argentine Food Code, with 25% containing foreign matter within the permissible limit of 2%, and the remaining 75% presenting inorganic components and wheat bran. Microscopic analysis facilitated the botanical diagnosis of the species.

The elements of diagnostic value not only contribute to the precise characterization of oregano but also underscore the significance of detailed microscopic observation in the identification and authentication of this plant species across various scientific and applied contexts.

Nevertheless, the challenges associated with ensuring the quality of food in the market are evident. Advocating for continuous efforts in policies and programs that promote food security is imperative to address current and future food-related challenges globally. The proposed methodology stands as an effective means to enhance quality control in the marketing of plant products in the province.

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