Evaluating Olive oil Quality and Food Safety Compliance in Tirana, Albania, Retail Markets

Josif Risto[1], Leomira Osmani-Lataj[2], Dritan Topi[3*]

[1]*Luarasi University, Department of Pharmacy, Faculty of Medical Sciences, Tirana, Albania*

[2]*Department of Plant Protection, Faculty of Agriculture and Environment, University of Agriculture of Tirana, Kamez, Tirana, Albania*

[3]*Department of Chemistry, Faculty of Natural Sciences, University Of Tirana, Blvd. Zog 1, Tirana, 1000, Albania*

Corresponding Author: dritan.topi@unitir.edu.al

KEYWORDS

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ABSTRACT

The debate over the significance of the quality of fats in our diet has been present in recent decades. Olive oil (OO) is unique among vegetable oils due to its alleged health benefits. Quality assessment, including the traceability of food products through control of the primary compounds, is a key step. Bottled OOs in retail markets have been subject to deceptive labeling, fraud, and adulteration. Health concerns are associated with mixing them with different vegetable oils. We investigated the fatty acid (FA) composition of several bottled olive oils from popular domestic brands in Tirana retail markets, using gas chromatography with a flame ionization detector and gas chromatography-mass spectrometry.

This study's results show that olive oils' fatty acid (FA) composition (OOs) does not reflect adulteration. The levels of trans-fatty acids (trans-FAs) were below the threshold established by European Union regulation 2568/91, as amended by 1989/2003. Specifically, oleic acid content ranged from 64.71% to 75.62%, palmitic acid from 8.43% to 14.26%, and linoleic acid from 6.64% to 13.1%. Furthermore, linolenic acid levels were below 1%, indicating that mixing with other vegetable oils is not evident. The trans-FA levels aligned with the label information, and the linolenic acid values were between 0.38% and 0.94%. The fatty acid profile of these olive oils demonstrated low saturated FA levels and a high concentration of monounsaturated FA. Our findings indicate that bottled olive oils from the Kalinjoti cultivar are appropriate for marketing as mono-cultivar brands. However, this is not advisable for bottled olive oils from Nisioti and Bardhi Tirana cultivars because they exhibit lower oxidative stability. .

INTRODUCTION

The Mediterranean diet is regarded as the leading dietary approach linked to preventing degenerative diseases and increasing lifespan (Gaforio et al., 2019). A key component of this diet is virgin olive oil (VOO), known for its beneficial nutritional properties owing to its fatty acid profile and phenolic compounds, as well as its distinctive flavour (Genovese, Caporaso & Sacchi, 2021; Topi et al., 2019). VOO is obtained from olives solely through mechanical or other physical methods, specifically avoiding heat to prevent oil composition alterations. The oil undergoes only washing, decantation, centrifugation, and filtering without further treatment (EC, 1991; Genovese, Caporaso & Sacchi, 2021; Sanmartin & Mencarelli, 2021).

The health and therapeutic benefits of virgin olive oil have gained significant consumer attention recently (Visioli & Galli, 1998; Topi et al., 2020). Consuming a Mediterranean diet rich in olives can lower blood pressure, particularly when 10 to 50 mL is consumed daily. Regular olive oil intake is linked to decreased body mass index (BMI) and a lower risk of breast cancer (Gaforio et al., 2019). Within the MedDiet framework, virgin olive oil has been shown to lower cardiovascular disease (CVD) risk and mortality among older individuals at high risk for cardiovascular issues (Guasch-Ferre et al., 2014). Polyunsaturated fatty acids (PUFAs) are essential for brain health, playing key roles in neuronal structure, memory, and cognitive functions. PUFAs contain two or more double bonds, whereas monounsaturated fatty acids (MUFAs) have a single double bond (Lichtenstein, 2005). Compounds such as docosahexaenoic acid and eicosapentaenoic acid offer a variety of benefits, including anti-inflammatory, hypotensive, hypolipidemic, hypocholesterolemic, vasoconstrictive, and antioxidant effects (Boskou, 2011; Adefegha, Oboh, & Oluokun, 2022).

Trans fatty acids (trans-FA) naturally occur in food from ruminant animals (rTFA), but they can also be produced through industrial processes (iTFA) (Mouratidou et al., 2014). The European Food Safety Authority advises keeping trans-FA consumption as low as possible while maintaining a nutritionally adequate diet (EFSA, 2018). Their presence is closely linked to systemic inflammation in individuals with heart disease, indicating that monitoring TFA intake may be crucial for preventing systemic inflammation and heart failure (Hernández et al., 2011; Boum et al., 2012).

The quality and authenticity of olive oil are determined by analytical data on various parameters, which must adhere to the limit values set by the European Commission (EC Reg. No 2568/1991) and its most recent amendment, EC Reg. No 1989/2003 (Guasch-Ferre et al., 2014). Additionally, EC Regulations 2081/92 and 2082/92 ensure the product's authenticity by allowing for labeling indicating the production region for extra virgin olive oil. This study concentrated on domestically produced olive oils (OO). It evaluates the quality of the marketed product 'olive oil' concerning EC regulation 1989/2003 regarding fatty acid content and the presence of trans fatty acids.

MATERIALS AND METHODS

Sample collection

Commercially sourced olive oils were acquired from the retail markets of Tirana city throughout 2021. The samples were chosen according to the specifications of label information, brand name, manufacturing technique, and kind of olive oil. All examined OO samples were sourced from a domestic origin. Forty samples from eight different brand-name olive oils were evaluated in this investigation. All samples were maintained in their original bottles at 4 °C in a dark environment from collection until chemical analyses.

Analytical methods

As Internal Standard was used pentadecanoic acid, direct basic transesterification in fatty acid methyl esters (FAME) was made according to EU regulation 1989/2003 (2003). An HP-6890 gas chromatograph fitted with a Flame Ionization Detector (GC-FID) was used to perform the FAME test. AOCS Official Method Ce 1b-89 was used in the calculations (Fyrestone D. 1994). Pure standards (Sigma-Aldrich, Supelco) were used to identify the fatty acids based on retention time comparisons. The proportion of total fatty acids was used to calculate fatty acids. Every sample was examined three times.

Statistical analysis

The entire dataset was assessed using a randomized block design, consisting of three replicates from fatty acid analysis. The results are displayed as mean values along with the standard error (n=3). A One-way ANOVA test, with a significance level set at $P<0.05$, was applied to evaluate the differences among the results.

RESULTS AND DISCUSSIONS

Analyzing the quality of food products that play a crucial role in consumers' diets is vital for health protection. High-value items, like 'Virgin Olive Oil,' are particularly susceptible to fraud. The fatty acid profiles derived from the brand name VOO aid in safeguarding consumer health and provide producers with insights regarding the quality of their products. The main fatty acids found in olive oil include palmitic acid (C16:0), oleic acid (C18:1), and linoleic acid (C18:2), alongside trace amounts of minor fatty acids such as palmitoleic (C16:1), stearic (C18:0), linolenic (C18:3), myristic (C14:0), heptadecanoic, and eicosanoic acids (Topi, Thomaj, Halimi, 2012; Gavrilova et al., 2020). Fatty acid composition can vary based on factors like production region, latitude, climate, cultivar, and fruit maturity stage. A variation in fatty acid composition exists between olive oils from the Southern and Northern Mediterranean regions. Olive oils from Greece, Italy, and Spain tend to have high oleic acid content but lower levels of linoleic and palmitic acids. In contrast, Tunisian olive oils contain more linoleic and palmitic acids and less oleic acid (Boskou, 2011).

Virgin Olive Oil (VOO) stands out for its unique nutritional and sensory qualities and is recognized as the main fat source in the traditional Mediterranean diet (Quintero-Florez et al., 2015; Topi et al., 2020). The Kalinjot variety, the most significant native olive cultivar, plays a crucial role in Albania's olive oil production, sourced from various locations in the Vlora and Mallakastra regions over the past decade (Velo & Topi, 2016). Oleic acid content ranges from 68.03% to 76.83%, linoleic acid from 7.85% to 14.22%, and palmitic acid from 8.54% to 13.62%. The linolenic acid level, which ranges from 0.63% to 0.89%, demonstrates that the marketed and consumed VOO aligns with the product labeling as olive oil (Topi et al., 2021).

Analysis of the primary fatty acids in olive oils indicates no fraudulent practices involving other edible oils, adhering to the limits set forth by FAO and EU Regulation No. 1989/2003. The predominant contributions to the fatty acid profile are from oleic acid (C18:1), linoleic acid (C18:2), and palmitic acid (C16:0). The linolenic acid level, varying from 0.38% to $0.94 \pm 0.01\%$, remains below 1% and falls within the permitted range according to FAO and EU Regulation No. 1989/2003 (Binetti et al., 2017). The geographical origin information for the olive oils, classified by codes A, B, C, F, G, and H, indicates that the predominant cultivar is the Kalinjoti olive variety. In contrast, the olive oil brand assigned code E reveals a different profile, suggesting that it is primarily derived from the *Nisioti* olive cultivar (Velo & Topi, 2017; Topi et al., 2021). Furthermore, olive oil brand code D shows elevated linoleic acid levels compared to other brands, indicating a geographical origin from the Tirana region, where the main olive cultivar is Bardhi Tirana (Topi, Thomaj & Halimi, 2012; Topi et al., 2021).

Table 1: Fatty acid composition of the bottled OOs from the market (%weight oil), (Mean Value±SD).

Formula	Brand A	Brand B	Brand C	Brand D	Brand E	Brand F	Brand G	Brand H
14:0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
16:0	10.71±1.18	14.26±1.23	14.26±1.01	8.94±1.80	15.22±0.91	10.30±0.82	10.38±0.71	8.43±0.61
16:1(n-9)	0.08±0.01	0.05±0.04	0.05±0.04	0.14±0.01	0.00±0.00	0.11±0.01	0.11±0.01	0.14±0.00
16:1(n-7)	0.37±0.02	1.42±0.56	1.42±0.30	0.22±0.01	0.94±0.03	0.44±0.01	0.50±0.02	0.20±0.02
17:0	0.12±0.01	0.00±0.00	0.00±0.00	0.14±0.02	0.13±0.01	0.10±0.01	0.10±0.00	0.15±0.01
17:1 (n-7)	0.18±0.01	0.00±0.00	0.00±0.00	0.20±0.01	0.20±0.02	0.17±0.01	0.15±0.00	0.22±0.01
18:0	3.23±0.09	2.23±0.21	2.23±0.32	3.27±0.41	2.38±0.20	2.76±0.21	2.80±0.31	3.04±0.21
18:1(n-9) trans	0.03±0.00	0.04±0.00	0.04±0.00	0.03±0.01	0.06±0.01	0.08±0.00	0.04±0.01	0.05±0.00
18:1(n-9) cis	75.62±2.01	71.65±3.43	71.65±2.13	75.41±2.23	64.71±3.24	74.98±2.02	74.41±1.05	76.92±1.08
18:1(n-7)	1.49±0.07	2.90±0.31	2.90±0.20	1.28±0.34	2.20±0.32	1.72±0.27	1.78±0.21	1.20±0.02
18:2(n-6) trans	0.01±0.00	0.00±0.00	0.02±0.00	0.01±0.00	0.00±0.00	0.03±0.00	0.01±0.00	0.00±0.00
18:2 (n-6) cis	6.99±0.35	6.64±0.21	6.64±0.40	8.85±0.54	13.24±0.41	7.98±0.43	8.36±0.51	8.12±0.71
20:0	0.50±0.01	0.29±0.01	0.29±0.01	0.48±0.01	0.34±0.02	0.42±0.02	0.42±0.02	0.47±0.01
18:3 (n-3)	0.48±0.02	0.52±0.03	0.52±0.01	0.72±0.02	0.54±0.14	0.71±0.08	0.69±0.04	0.74±0.03
20:1 (n-9)	0.24±0.01	0.06±0.00	0.06±0.00	0.34±0.01	0.11±0.05	0.30±0.01	0.30±0.01	0.37±0.02
20:2 (n-6)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
21:0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
20:3 (n-3)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
22:0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
ω-6/ω-3	14.41	12.86	12.86	24.51	24.51	11.18	12.12	10.98
SFAs	14.56	16.78	16.78	18.05	18.05	13.58	13.70	12.09
MUFAs	77.96	76.09	76.09	68.16	68.16	77.71	77.25	79.06
PUFAs	7.47	7.16	7.16	13.78	13.78	8.70	9.05	8.86
Oleic/Linoleic	10.82	10.79	10.79	4.89	4.89	9.39	8.90	9.48

Trans-fatty acid levels in VOO

Research on trans-FA isomers such as trans-C18:1(n-9), trans-C18:2(n-6), and trans-C18:3(n-3) in the examined olive oils shows a total trans-FA level ranging from 0.04 to 0.11%. As per EU regulation 1989/2003, the trans-FA threshold is set at 0.05% w/w oil, indicating non-compliance with labeling requirements. In two specific instances, codes B and F, the average values suggest that the products should be recalled, and the labeling "Extra Virgin Olive Oil' needs revision. Intervention studies indicate that diets rich in trans-FA negatively affect blood lipids in a dose-dependent manner, heightening the risk of coronary heart disease compared to diets rich in cis-MUFAs or cis-PUFAs. (EFSA, 2018).

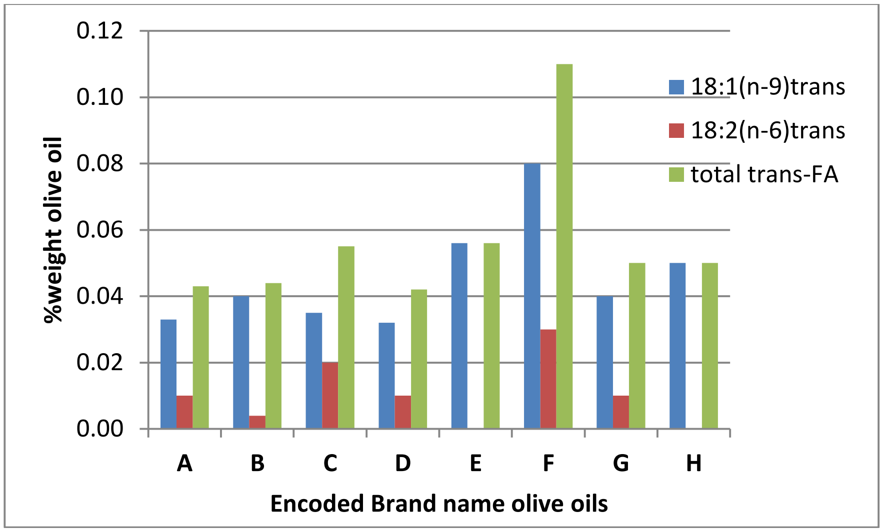

Figure 1: Trans-FA percentage of the bottled olive oils.

Fatty acid clusters and health implications

An evaluation of the olive oils reveals that the (ω-6)/(ω-3) ratio, a key parameter recommended by nutrition experts, typically reflects a good source of lipids, except for brands D and E. It is known that low-density lipoprotein cholesterol tends to increase with saturated fatty acid (SFA) intake, a trend not observed with monounsaturated fatty acids (MUFAs). In contrast, polyunsaturated fatty acids (PUFAs) appear to have no impact (Baum et al., 2012). The categorization of fatty acids into SFA, MUFA, and PUFA groups suggests domestic olive oils are particularly rich in MUFA and SFA components (Topi, Thomaj, Halimi, 2012; Topi et al., 2021). From a nutritional and technological perspective, olive oil's fatty acid composition is crucial to its nutritional value. It exhibits a high oleic and low linoleic acid concentration (Hernández et al., 2011).

Table 2: Nutritional indicators of the bottled Olive Oils.

Parameter	**Brand A**	**Brand B**	**Brand C**	**Brand D**	**Brand E**	**Brand F**	**Brand G**	**Brand H**
ω-6/ω-3 ratio	14.41	12.86	12.86	24.51	24.51	11.18	12.12	10.98
SFA	14.56	16.78	16.78	18.05	18.05	13.58	13.70	12.09
MUFA	77.96	76.09	76.09	68.16	68.16	77.71	77.25	79.06
PUFA	7.47	7.16	7.16	13.78	13.78	8.70	9.05	8.86
Oleic/Linoleic ratio	10.82	10.79	10.79	4.89	4.89	9.39	8.90	9.48

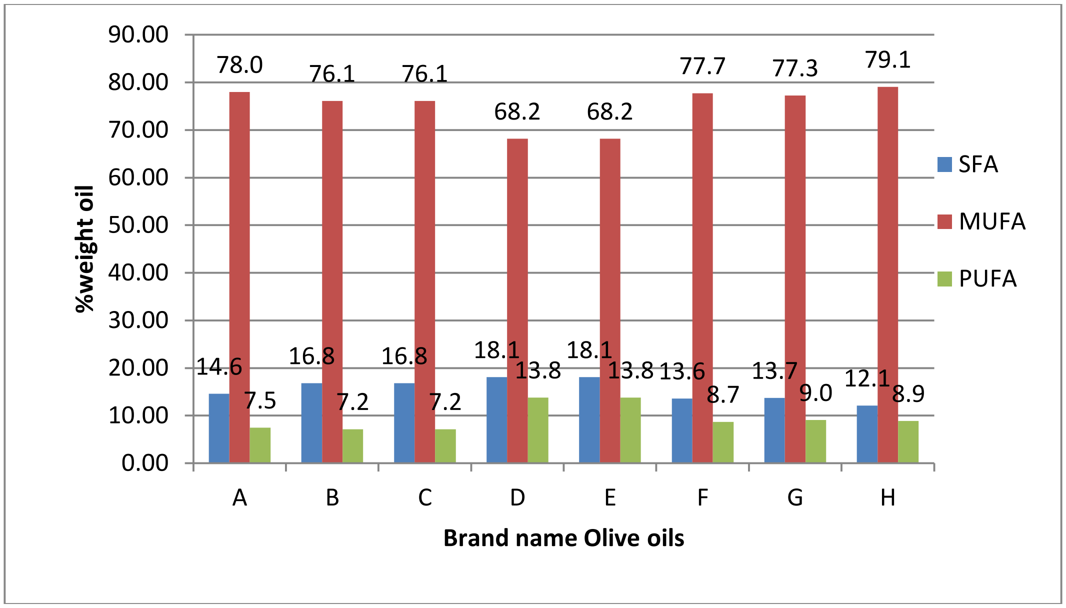

Figure 2: SFAs, MUFAs, and PUFAs of studied bottled olive oils.

The oxidative stability of VOO is influenced by its phenolic profile and fatty acid (FA) content. Oils with a higher oleic acid to linoleic acid ratio are generally more resistant to oxidation than those with a lower ratio (Spatari et al., 2017; Topi et al., 2017). The oleic/linoleic ratio indicates that brands D and E have lower oxidation stability than other brands in this study. Therefore, I suggest a blend of the Kalinjoti and Nisioti olive cultivars yield VOO with enhanced oxidative stability and a superior nutritional profile. Furthermore, the brand utilizing the Bardhi Tirana olive cultivar should blend with other local cultivars, like the Frantoio cv.

CONCLUSIONS

An investigation into bottled olive oils available in retail markets revealed no adulteration in the fatty acid composition among the sampled oils. The results indicated consistency between the label information pertaining to the origin and the three olive cultivars: *Kalinjot, Nisioti,* and *Bardhi Tirana*. The brands examined exhibited a favorable ω-6/ω-3 ratio within their nutritional profiles; therefore, producers are advised to adhere to stringent technological mixing protocols. This approach will assist them in ensuring the integrity and health claims made to consumers. The oxidative stability of these oils is associated with the predominant olive variety native to its region of origin. It can be concluded that brands offering bottled olive oils composed of *Kalinjot* are suitable for promotion as mono-cultivar olive oils. Conversely, due to their lower oxidative stability, such marketing is ill-advised for oils derived from the Nisioti and Bardhi Tirana varieties. Ensuring traceability for domestically sourced olive oil will protect consumer health against adulteration practices and support local producers by protecting their products from deceptive labeling practices.

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