Integrated Protection of Olive Crops
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Integrated production and quality of Galega olive oil

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Abstract: A study has been carried out to evaluate the influence of integrated olive production on the quality of Galega virgin olive oil. On three consecutive years, olive samples from two different groves in integrated production were taken, and submitted to extraction in industrial mills. The analytical determinations in olive oil were acidity, peroxide index, K_{232} and K_{270}, sensory analysis, fatty acid composition, total phenol compounds, tocopherols, oxidation stability and organophosphate pesticides. Quality criteria were within the European Union limits for extra virgin olive oil, and the organophosphate pesticides residues were always undetectable.

Key words: olive fruit fly, olive anthracnose, quality criteria, *Olea europaea*, fatty acids.

Introduction

Olive oil, one of the oldest known vegetable oils, is extracted from the fruits of the olive tree (*Olea europaea* L. var. *europaea*) using solely mechanical means. The fact that the oil extraction is solvent-free and natural antioxidants are maintained in the oil is reflected in the high nutritional and economic value of this product. Continuous effort is being made in order to preserve its high quality features; moreover one of the most important quality features is the low concentration of pesticide residues, always lower than the MRL.

Virgin olive oils of the Protected Designation of Origin (PDO) “Beira Baixa” are mainly extracted from cultivar Galega Vulgar. The unique sensorial properties of this olive oil, together with its high oxidative stability during long storage make it particularly appreciated. From a commercial point of view the blend of Galega olive oils with Picual olive oils showed higher oxidative stability and lower bitter taste intensity (Pinheiro-Alves et al., 2002). However, Galega cultivar is strongly attacked by the olive fruit fly (*Bactrocera oleae* Gmelin) and highly susceptible to anthracnose (*Colletotrichum* spp.). The loss of quality caused by olive fruit fly is associated with the presence of fungi in the galleries made by the larvae. In optimal conditions, *i.e.* with high humidity and mild temperatures, olives will rot and produce oil with higher acidity and inferior sensorial characteristics.

Olive anthracnose is the disease that causes the main olive oil downgrade. Very high levels of acidity and other inferior quality parameters have long been associated with olive anthracnose. Furthermore, the quality rapidly decreases after harvesting when olives are stored in poor conditions (Torres-Vila *et al*., 2003).

The use of the Integrated Production guidelines decreases the level of these enemies, and therefore substantially improves olive oil quality and olive crop sustainability (Cayuela *et al*., 2006). Also, Integrated Production will assure low levels of pesticide residues.

The evolution of these olive crop major enemies, which most affect olive oil quality, olive fruit fly and anthracnose, was assessed on Galega Vulgar cv. in Beira Baixa region, Portugal, under Integrated Production.

Several analytical parameters of virgin olive oil, as well as organophosphate pesticides residues were studied.

Material and methods

Two olive groves located in Castelo Novo (CN) and Sarzedas (SZ), Beira Baixa region of Portugal, where IPM was fully employed since 2001, were evaluated for the success of this agricultural system on olive oil quality. Castelo Novo grove was 6 years old and Sarzedas had more than 80 years. The study was carried out during three years, from 2004 to 2006.

Hundred sampled olives were observed weekly for the presence of eggs, live larvae, and pupae of the fly. Organophosphate insecticides were sprayed when the economical threshold of 8% was achieved.

Olive anthracnose was evaluated by the presence of symptoms on 100 fruits sampled weekly. As Galega cultivar is very susceptible to anthracnose, copper fungicides were applied when the weather conditions were favourable for the pathogen, as the Portuguese IPM guidelines recommend (Gomes & Cavaco, 2003).

The ripening degree was determined following the guidelines of Estación de Olivicultura y Elaiotecnia, Jaén, Spain, which defines ripeness as a function of fruit colour in skin and pulp (Hermoso *et al*., 1997).

Olives were subjected to extraction process in industrial mills in a continuous centrifugation system.

Analytical methods

Acidity value, peroxide index, UV light absorption (K_{232} and K_{270}), fatty acids, and sensory analysis were carried out following the analytical methods described in EC/2568/91, 1429/92 EU Regulations and later amendments.

Total phenol compounds were determined employing Folin-Ciocalteau reagent with liquid/liquid extraction and quantification by VIS spectroscopy.

Oxidative stability was measured by the Metrohm Rancimat Model 670 (T=100ºC, Air=20 $dm^3\ h^{-1}$).

Tocopherols were measured by normal-phase high-performance liquid chromatography (NP– HPLC), fluorescence detection with excitation set at 290 nm and emission at 330 nm. A Lichrosorb Si 60 column (5 µm) and a flow rate of 1.2 ml/min was used at room temperature.

Organophosphate pesticides residues were determined by gas chromatography (GC) following the method described in NP EN 1528-1/2/3:2002.

Statistical analysis was performed using SPSS version14.0.

Results and discussion

The percentage of olives occupied by live larvae and eggs in Castelo Novo (Figure 1) and Sarzedas (Figure 2) reveal that both locations had the presence of the fly, although the attacks were more severe in Castelo Novo, reaching 22% in 2004 and 2005. In the following year the level of attack was much lower in both locations, still in CN there was the need to spray once because the level just reached 8%. Two sprays with organophosphates insecticides were done in 2005 and 2006, in CN, but only one spray with the same kind of insecticides was applied in each one of those years in SZ. It can be concluded that the olive fly population is much higher in CN. This assumption is confirmed with data from curve flights (Luz et al., 2006).

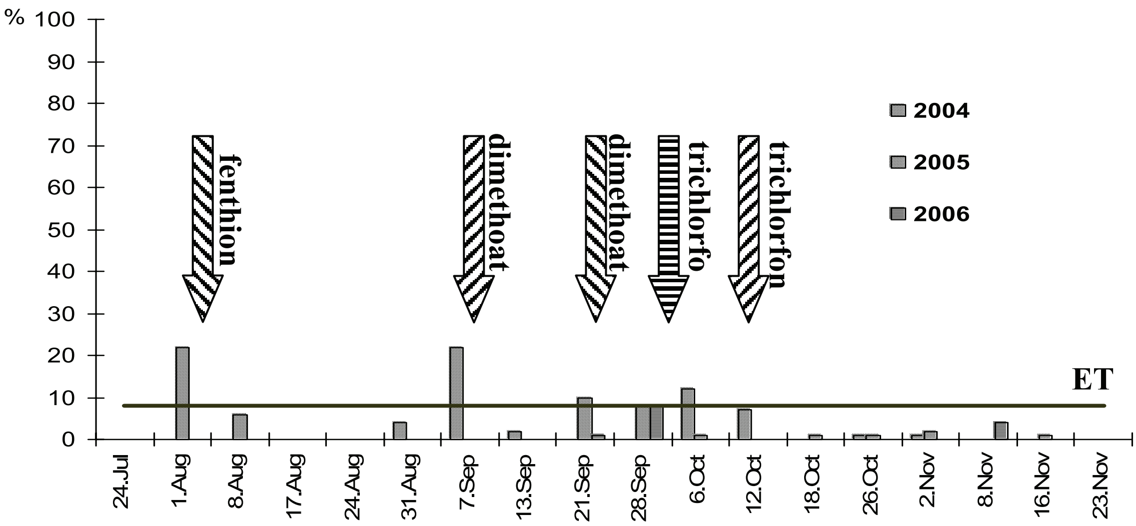

Figure 1. Percentage of olives occupied by live larvae and eggs in Castelo Novo (CN).
ET – economical threshold.

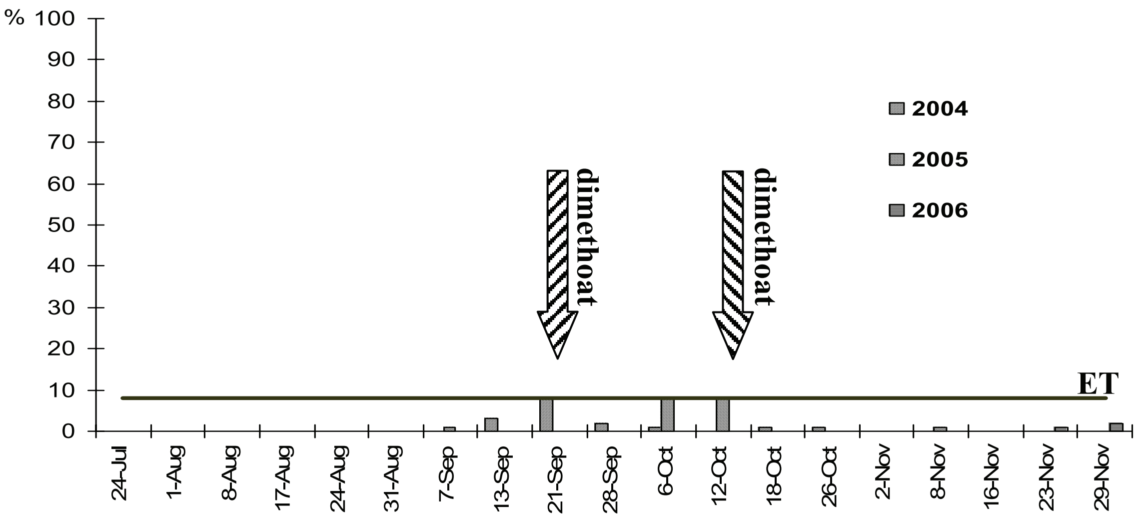

Figure 2. Percentage of olives occupied by live larvae and eggs in Sarzedas (SZ).
ET – economical threshold.

Olive trees were sprayed only once, in each year, with copper oxychloride, in CN, but in SZ in 2004 and 2006 there was the need of two sprays due to the humid weather conditions and later fruit ripening. All sprays were done in September/October as a result of the autumnal rainfall onset.

In what concerns quality criteria (acidity, peroxide index, and UV absorbances) high quality virgin olive oils were obtained, during the whole study (Table 1). All oil samples had no sensorial defects and fruitiness was always superior to zero. The oils were characterised by low bitter intensity and pungent notes for the ripening degrees achieved, because the Galega olive oil has low polyphenols contents.

The high oleic/linoleic ratio explains the high oxidative stability of Galega olive oil (Peres et al., 2000), as other authors found for Picual olive oil (Aparício *et al*., 1999).

The content of alpha-tocopherol (vitamin E) is also important from a nutritional point a view for Galega olive oils and contributes for the shelf life of the oil (Blekas *et al*, 1995).

The pesticide residues were always lower than the analytical method quantification limit.

Table 1. Ripening degree of olives and analytical parameters of Galega olive oils.

Analytical parameters	**2004**	**2005**	**2006**
Ripening degree	4.3±0.3 b	4.3±0.6 b	3.3±0.6 a
Acidity (% oleic acid)	0.10±0.07 a	0.14±0.05 a	0.33±0.15 b
Peroxide index (meq O_2 kg^{-1})	11.5±2.0 b	9.4±1.6 a	14.2±2.3 c
K_{270}	0.104±0.037 a	0.081±0.025 a	0.119±0.017 b
K_{232}	1.615±0.187 b	1.347±0.155 a	1.595±0.097 b
Oxidative stability (hours)	42.4±11.1 a	49.2±8.4 a	61.1±9.2 b
Total phenols (as caffeic acid, mg kg^{-1})	77.4±19.4 a	82.2±28.2 a	81.3±28.7 a
α-tocopherol (mg kg^{-1})	151.1±14.7 ab	141.9±8.5 a	159.6±9.5 b
Monounsaturated fatty acids (%)	77.3±0.3 a	77.2±0.7a	77.2±1.2 a
Polyunsaturated fatty acids (%)	5.5±0.16 a	5.4±0.35 a	5.5±0.49 a
Saturated fatty acids (%)	17.2±0.34 a	17.4±0.46 a	17.0±0.77 a
Oleic/linoleic ratio	15.9±0.5 a	15.9±1.2 a	15.4±1.6 a

Mean values ± standard deviation. In each row, values with different letters differ significantly, Tukey test ($p<0.05$).

In conclusion, Galega cultivar, under Integrated Production, produces an olive oil of very high quality and is a safe food, taken into account the low number of pesticide sprays and the pesticide residues.

Acknowledgements

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