IOC STUDY ON AUTHENTIC OLIVE OILS DISPLAYING OFF-LIMIT PARAMETERS: Δ7-STIGMASTENOL

The composition of edible vegetable oils in terms of their fatty acids and other components is dependent on the plant from which the oil is extracted. It differs according to the variety of the plant and to the soil and climatic conditions in the producing area. The average composition is known and stable, lying within a specific interval for each compound, and permits identification of the botanical origin of the oil. In some ways it is the by-line of the oil.

This average composition is very important in fighting fraud and ensuring that the olive oil that consumers buy for its health or sensory properties has not been mixed with other, cheaper vegetable oils. The International Olive Council (IOC), the UN-brokered intergovernmental organisation mandated to administer the International Agreement on Olive Oil and Table Olives, has been assigned several roles by its membership of 16 producing countries plus the European Union which together account for more than 96 pc of world production, one of which is to fix the average composition of olive oil products in a trade standard.

In specific soil and climatic conditions a variety of olive may sometimes produce oil in which an authenticity or quality marker may fall outside the established interval; as a result, the oil does not comply with the IOC trade standard on which the CODEX standard is very largely modelled. In such cases, a balance can be sought between allowing the necessary flexibility to recognise that the oil is compliant with the standard and preventing such flexibility – open to all business operators – from increasing the likelihood of fraud by permitting mixtures with other vegetable oils because they cannot be identified with the same precision. To find such a balance, the IOC has developed what are known as decision trees. The thinking behind these trees is that when a specific parameter in an oil falls outside the established interval, its composition has to meet tougher limits for other parameters in order to make allowances for its special profile and to rule out the risk of the addition and non-detection of other vegetable oils.

Clearly, this is a balancing act where flexibility has to be juggled against risk and where the volume of non-compliant production also has to be taken into account.

Against this background, the IOC Executive Secretariat wishes to make a number of stringently investigated, objective comments regarding Δ7-stigmastenol, one of the components used to certify the purity of olive oil for which a decision tree has recently been adopted.

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In 2003, the Codex Alimentarius Commission adopted the revised Codex standard for olive oils and olive pomace oils at its 26th session (Rome, 30 June–7 July 2003), since when the Δ7-stigmastenol limit fixed in the IOC trade standard remained unchanged until May 2013 when a decision tree was adopted. No general, across-the-board amendment of this limit was planned because this could jeopardise the authenticity of the large majority of oils produced in the world, with the ensuing negative repercussions for consumers.

Nevertheless, the IOC realised that the values of specific parameters in genuine oils could fall outside the limits fixed in the IOC trade standard. Its Members therefore considered it essential to collect swift, reliable varietal data from producing countries in order to build an IOC reference database and so avoid the problems caused by erroneous data or data of unknown origin. Consequently, it decided to mandate an IOC expert group to conduct an exhaustive study on this issue in order to ascertain the general state of play (not just regarding Δ7-stigmastenol), with the cooperation and participation of the producing countries.

From the outset, the IOC experts stressed one fundamental aspect: the parameters at issue concerned product authenticity. A cautious, rigorous approach to the study was therefore called for; the subject area needed to be clearly demarcated and the parameters for review and the range of fluctuation in the limits needed to be clearly identified. They believed that a study of this type was needed to demonstrate that the solution for genuine olive oils with off-limit values was to apply the independent decision trees or decision tables proposed by the experts in order to guarantee them market access without benefiting fraud.

The study was carried out for three years (2009–2012). As agreed at the Codex session, the IOC Executive Secretariat invited member and non-member countries of the IOC to provide input for the survey. Requests for samples were circulated every year but some countries sent only a few samples or none at all, despite the agreement reached at the Codex meeting. A follow-up study is underway to examine other parameters besides campesterol and delta-7-stigmastenol. Therefore, the Executive Secretariat continues to receive samples in which other characteristics are off-limit.

The following picture emerges from the results of the testing conducted so far by the IOC chemistry expert working group.

PART 1. PARTICIPANT COUNTRIES IN THE IOC STUDY

A total of 198 samples from 13 countries (Algeria, Argentina, Australia, Cyprus, Greece, Israel, Morocco, Portugal, Slovenia, Spain, Syria, Tunisia and Turkey) were submitted for the study: 65 in the 1st year, 76 in the 2nd and 57 in the 3rd. One hundred and thirty-three of these samples were analysed, 121 of which were found to have at least one deviant parameter.

The number of samples analysed and found to be deviant is itemised by country in the table below:

Country	Number of samples analysed	Number of deviant samples
Argentina	34	34
Australia	5	4
Morocco	7	7
Portugal	3	3
Spain	19	19
Syria	38	36
Tunisia	19	11
Turkey	8	7

The reasons for not analysing all the samples submitted were that:

1. Not enough quantity was provided
2. The survey questionnaire was not completed
3. No analytical profile was provided
4. None of the parameters was outside the limits

Eighty-four of the deviant samples recorded one parameter outside the limits. One sample was very remarkable in that it was deviant for eight parameters.

The most frequent deviations observed in the samples of extra virgin olive oil were in: campesterol, Δ7-stigmastenol, apparent β-sitosterol, total sterols, waxes, palmitic, palmitoleic, oleic, linoleic, linolenic, gadoleic, lignoceric, ΔECN42, monopalmitin, erythrodiol + uvaol.

In the case of the lampante samples, deviations were noted in the following criteria: Δ7-stigmastenol, apparent β-sitosterol, total sterols, erythrodiol + uvaol.

Only two parameters deviated from the official limits in the olive pomace oils tested: Δ7-stigmastenol, apparent β-sitosterol.

Campesterol and Δ7-stigmastenol were the parameters for which the most samples exhibited deviations. In all, 37 samples of extra virgin olive oil were found to have deviant campesterol levels and a further 37 in the same category recorded off-limit Δ7-stigmastenol values.

The kind and number of deviant parameters are presented by country in the following table:

Country	DEVIANT PARAMETER	Number of deviant parameters
ARGENTINA (n=34)	campesterol, apparent β-sitosterol (extra & virgin), waxes, palmitic, palmitoleic, oleic, linoleic, linolenic, lignoceric, ΔECN42, monopalmitin	11
AUSTRALIA (n=5)	campesterol, gadoleic	2
MOROCCO (n=7)	linolenic, ΔECN42	2
PORTUGAL (n=3)	erythrodiol + uvaol	1
SPAIN (n=19)	**Δ7-stigmastenol**, total sterols, erythrodiol + uvaol, linoleic	4
SYRIA (n=39)	**Δ7-stigmastenol** (extra, virgin and lampante), apparent β-sitosterol (lampante), total sterols, ΔECN42	4
TUNISIA (n=19)	**Δ7-stigmastenol** (olive pomace), apparent β-sitosterol (olive pomace)	2
TURKEY (n=36)	**Δ7-stigmastenol** (extra, virgin and lampante), apparent β-sitosterol (lampante), erythrodiol + uvaol	3

PART 2. PROCESSING OF RESULTS

GENERAL COMMENTS

- Most of the samples were analysed by three labs.
- Deviations were not confirmed in all cases because the lab results in some cases were contradictory.
- Some samples were not analysed for all the parameters, particularly those included in the decision tree. As a result, it was difficult to check the effectiveness of applying the decision tree in all cases.
- Large discrepancies were observed in the application of the methods for the determination of the sterols. The unified method gives higher contents of Δ7-stigmastenol and erythrodiol +

uvaol. Hence, when Δ7-stigmastenol content was low, the results were very similar. However, at high concentrations of Δ7-stigmastenol, the results diverged both between and within the labs. This is demonstrated in the next table.

Results for sterols and erythrodiol+ uvaol methods

Parameter	**Test code**	**Sterols and E+U two methods**		**Sterols and E+U unified**	
		1ST	**2ND**	**1ST**	**2ND**
Δ7-stigmastenol %		0.76	0.50	0.79	0.60
	PA41	0.66	0.52	0.86	0.71
	PA42	0.66	0.61	0.88	0.79
	PA43	0.82	0.65	1.01	0.80
	PA44	0.59		0.87	
	PA45	0.32		0.98	
	PA46	0.36		0.89	
	PA30	0.39		0.38	
	PA31	0.19		0.18	
	PA32	0.34		0.36	
apparent β-sitosterol %	PA44	95.20		94.27	
	PA45	95.79		93.87	
	PA46	95.79		94.32	
erythrodiol+uvaol %	PA44	1.48		2.49	
	PA45	0.91		2.37	
	PA46	1.23		2.36	

APPROACH

The results for the samples tested were divided into subgroups by deviant parameter and oil category. Only one result was needed for each parameter and sample for data processing purposes. Consequently, the results were evaluated on the basis of the **worst case** as opposed to the mean value of the samples analysed. In other words, the highest value recorded per sample was taken into account for the parameters with a maximum limit (campesterol, Δ7-stigmastenol, etc.) and the lowest for the parameters with a minimum limit (apparent β-sitosterol). Hence, data processing took into account all the samples for which even just one laboratory detected a deviation.

The following was then examined:

A. **<u>Effectiveness of the decision tree in the detection of olive oil fraud</u>,** i.e. the risk of adulteration when a decision tree is applied due to a permitted increase in the official limit of a parameter.
This is considered a very important step before the adoption of a decision tree because the first and foremost concern is to protect olive oil from fraud. The purity criteria fixed in the

International Standards are used to detect olive oil adulteration with other oils and their limits have been adopted after thorough studies. Any change in these limits must be mindful of the risk of fraud and must only be adopted if they do not increase the margin for fraud.

This procedure comprised two steps:

1. Firstly, a bar-line combination chart was created to compare the effectiveness of a parameter vis-à-vis a deviant parameter in the detection of olive oil adulteration. This step permits identification of those parameters which can replace the deviant parameter. This type of chart has primary and secondary axes and the limits of the two parameters, while different, are depicted on the same horizontal line. The first parameter is illustrated by a bar, while the second one is plotted as black dots connected in a line. The second parameter is good for the detection of adulteration if the black dot lies above the line-limit. In addition, if the dot is higher than the top of the bar, the second parameter will be better for fraud detection than the first.
2. Secondly, the percentage of seed oil detectable in olive oil was calculated by using not only the purity criteria that proved effective in the first step, but also some others and applying them at the official or even stricter limits. This step allowed us to conclude whether there are other parameters (aside from the deviant one) that are effective in the detection of fraud, or whether the deviant parameter is irreplaceable.

B. Effectiveness of the application of the decision tree to the deviant samples analysed

This entailed calculating the statistical data for the deviant samples and the percentage of samples tested that conformed to the proposed limit for each parameter.

The most suitable parameters were selected on the basis of sample conformity and a decision tree was created for each deviant parameter and category of virgin olive oil.

The results of the above evaluation for the deviant parameter Δ7-stigmastenol are reported below.

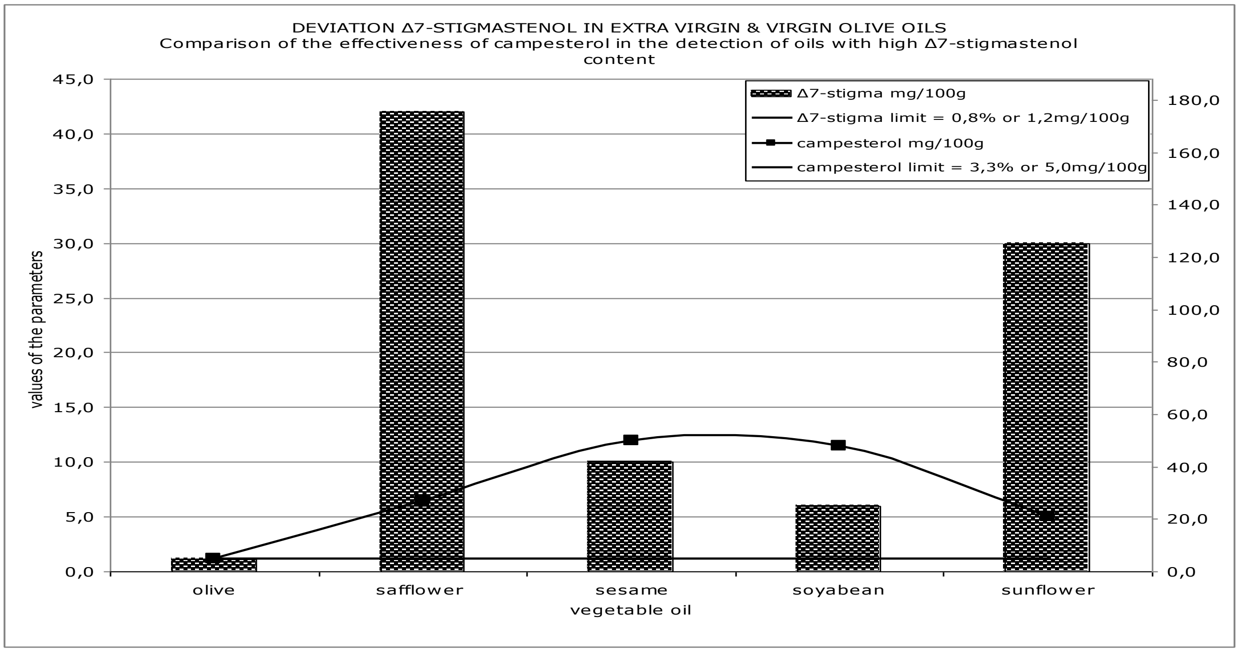
DEVIATION: Δ-7-STIGMASTENOL IN VIRGIN OLIVE OILS AND OLIVE POMACE OILS

The results obtained for the samples tested revealed that deviations in Δ7-stigmastenol content occur in edible and lampante virgin olive oils and olive pomace oils.

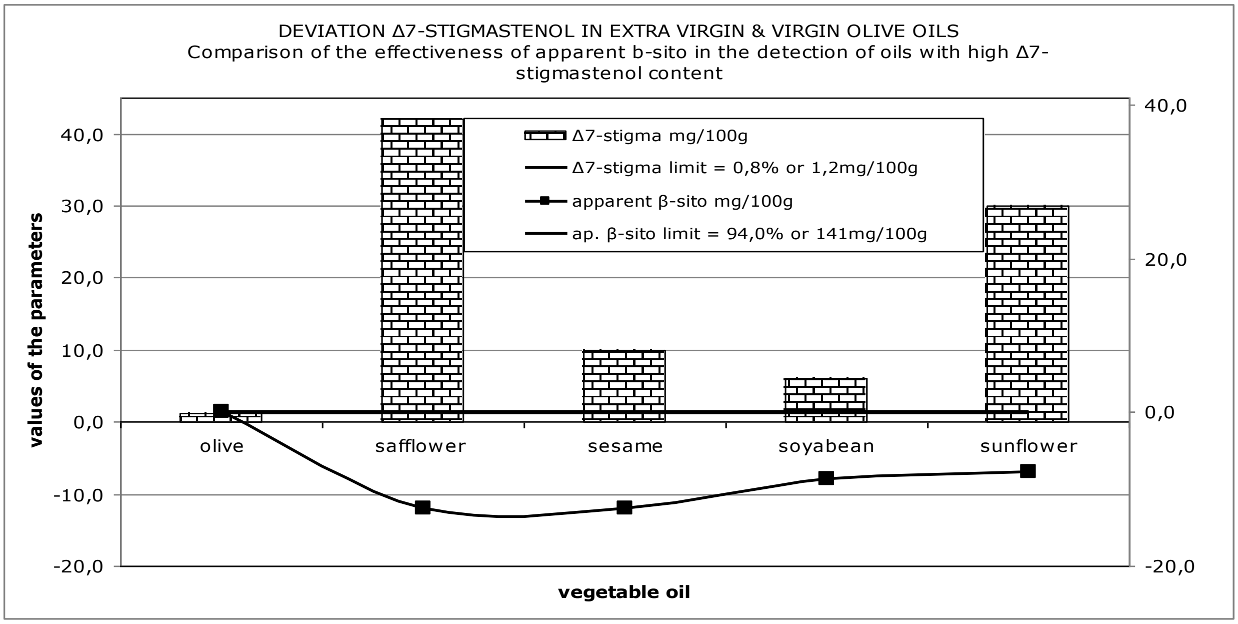
A. Examination of the effectiveness of the decision tree in the detection of olive oil fraud

1. Sunflower, safflower, soyabean and sesame oil are high Δ7-stigmastenol seed oils. The same oils also have a very high stigmasterol content. Consequently, stigmasterol (limit ≤1.4%) might be very effective in detecting the addition of these seed oils to virgin olive oils and olive pomace oils.

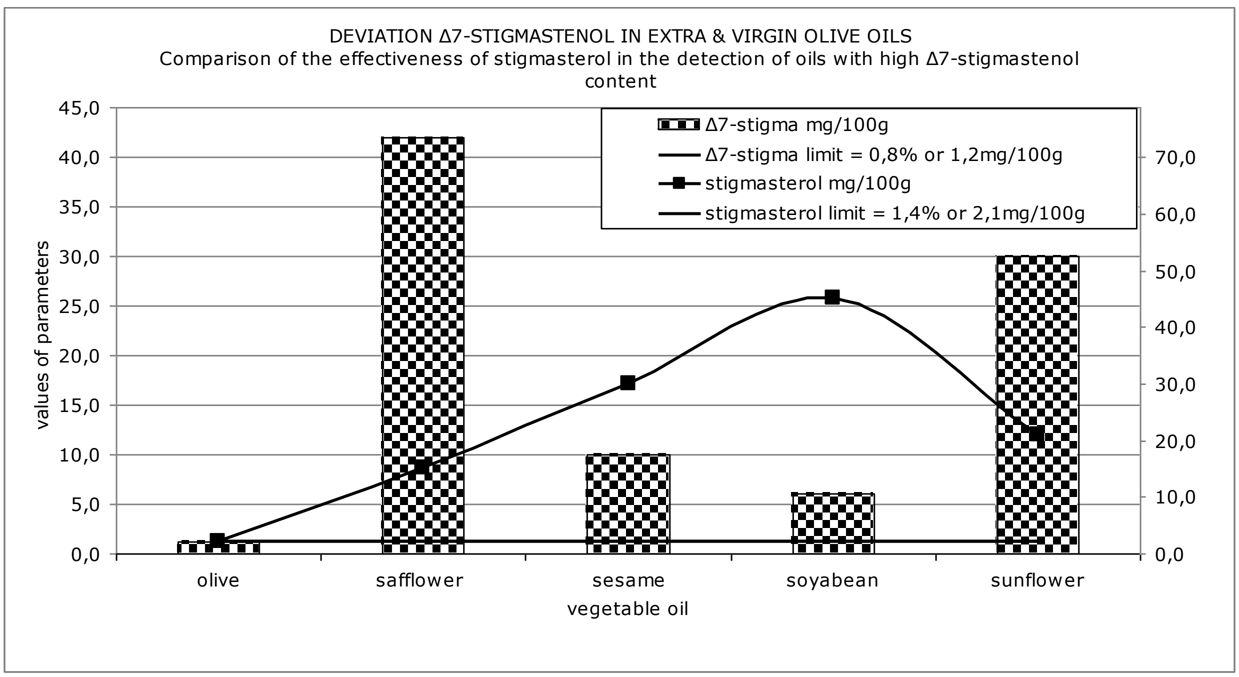
Bar-line combination charts were created for extra virgin and virgin olive oils. Campesterol, apparent β-sitosterol and stigmasterol were compared in the following three bar-line combination charts to assess their effectiveness in the detection of the adulteration of olive oil. The limit intended for inclusion in the decision tree was the limit applied for the parameter. Total sterols content was taken into account. The values of the parameters plotted on the y-axis are therefore expressed in mg/100g. Since apparent β-sitosterol is a parameter with a minimum limit, its values are negative in the chart.
Similar conclusions can be drawn when this procedure is applied to lampante virgin olive oils and olive pomace oils.



Conclusion: Campesterol is more effective than Δ7-stigmastenol for the detection of soyabean and sesame oil.



Conclusion: Apparent β-sitosterol is effective in the detection of safflower, sesame, soyabean and sunflower oil.



Conclusion: Stigmasterol is more effective than Δ7-stigmastenol for the detection of soyabean and sesame oil.

2. Calculation of the percentage of detectable seed oil in olive oil using various purity criteria in order to ascertain whether some other parameters (aside from Δ7-stigmastenol, the deviant parameter) are effective in the detection of fraud or whether the deviant parameter is irreplaceable.

In all cases, the percentage of detectable seed oil in olive oil was calculated by using not only the proposed limits (0.7% or 0.8%) for Δ7-stigmastenol, but also the official limit. This calculation indicates how the effectiveness of Δ7-stigmastenol will change if its limit is raised from 0.5% to 0.7% or 0.8%. Since three different limits have been proposed for campesterol (2.8%, 3.3% and 3.5%), its effectiveness was determined by applying these three limits. Similarly, the effectiveness of stigmasterol was examined by using two limits and that of apparent β-sitosterol by using the official limit (≥93.0%) and the proposed one of ≥94.0%.

The following tables present the results of this exercise. The parameters that are more effective than the deviant detection-wise are shaded in grey.

Detection of olive oil adulteration with high Δ7-stigmastenol oils

	Parameter used for fraud detection	Parameter limit applied	Percentage of detectable seed oil in olive oil	Value used for	
				olive oil	seed oil
safflower	Δ7-stigmastenol %	0.5	≈0.8%	0.3	14.0
	Δ7-stigmastenol %	0.7	≈1.5%	0.3	14.0
	Δ7-stigmastenol %	0.8	≈1.9%	0.3	14.0
	Campesterol %	2.8	≈2.5%	2.5	9.0
	Campesterol %	3.3	≈6.5%	2.5	9.0
	Campesterol %	3.5	≈8.2%	2.5	9.0
	Stigmasterol %	1.3	≈2.5%	1.1	5.0
	Stigmasterol %	1.4	≈4.0%	1.1	5.0
	Apparent β-sitosterol %	93.0	≈1.2%	94.0	52.0
	Apparent β-sitosterol %	94.0	≈0.6%	94.5	52.0
	ΔECN42 (absolute value)	0.1	<1.0%	0.05	5.3
			total sterols	1500	3000
sesame	Δ7-stigmastenol %	0.5	≈4.0%	0.3	2.0
	Δ7-stigmastenol %	0.7	≈8.5%	0.3	2.0
	Δ7-stigmastenol %	0.8	≈11.0%	0.3	2.0
	Campesterol %	2.8	≈1.2%	2.5	10.0
	Campesterol %	3.3	≈3.4%	2.5	10.0
	Campesterol %	3.5	≈4.5%	2.5	10.0
	Stigmasterol %	1.3	≈1.2%	1.1	6.0
	Stigmasterol %	1.4	≈2.0%	1.1	6.0
	Apparent β-sitosterol %	93.0	≈1.0%	94.0	69.0
	Apparent β-sitosterol %	94.0	≈0.6%	94.5	69.0
	ΔECN42 (absolute value)	0.1	<1.0%	0.05	4.3
			total sterols	1500	5000
soyabean	Δ7-stigmastenol %	0.5	≈7.0%	0.3	2.0
	Δ7-stigmastenol %	0.7	≈13.5%	0.3	2.0

	Δ7-stigmastenol %	0.8	≈17.0%	0.3	2.0
	Campesterol %	2.8	≈1.2%	2.5	16.0
	Campesterol %	3.3	≈3.0%	2.5	16.0
	Campesterol %	3.5	≈3.8%	2.5	16.0
	Stigmasterol %	1.3	≈0.7%	1.1	15.0
	Stigmasterol %	1.4	≈1.1%	1.1	15.0
	Apparent β-sitosterol %	93.0	≈1.5%	94.0	65.0
	Apparent β-sitosterol %	94.0	≈0.8%	94.5	65.0
	ΔECN42 (absolute value)	0.1	<1.0%	0.05	2.2
			total sterols	1500	3000
sunflower	Δ7-stigmastenol %	0.5	≈1.1%	0.3	10.0
	Δ7-stigmastenol %	0.7	≈2.1%	0.3	10.0
	Δ7-stigmastenol %	0.8	≈2.5%	0.3	10.0
	Campesterol %	2.8	≈3.5%	2.5	7.0
	Campesterol %	3.3	≈9.5%	2.5	7.0
	Campesterol %	3.5	≈12.0%	2.5	7.0
	Stigmasterol %	1.3	≈1.7%	1.1	7.0
	Stigmasterol %	1.4	≈2.6%	1.1	7.0
	Apparent β-sitosterol %	93.0	≈1.5%	94.0	68.0
	Apparent β-sitosterol %	94.0	≈1.0%	94.5	68.0
	ΔECN42 (absolute value)	0.1	<1.0%	0.05	0.5
			total sterols	1500	3000

Conclusions:

- Apparent β-sitosterol and ΔECN42 are the most sensitive parameters for the detection of high Δ7–stigmastenol seed oils and are more effective at the respective limits of ≥94.0% and ≤|0.1|.
- Campesterol (limit ≤3.3%) is more effective than Δ7–stigmastenol (limit ≤0.5%) for the detection of sesame and soyabean oil.
- Stigmasterol (limit ≤1.4%) is a good parameter for the detection of safflower, sesame, soyabean and sunflower oil and is more effective than Δ7–stigmastenol (limit ≤0.5%) in the detection of sesame and soyabean oil.
- Stigmastadiene (limit ≤0.05mg/kg) is very effective for the detection of the adulteration of virgin olive oil with all refined seed oils.

Consequently, in cases where an edible virgin olive oil has a Δ7–stigmastenol content between 0.5% and 0.7% or 0.8%, other parameters exist which ensure their authenticity.

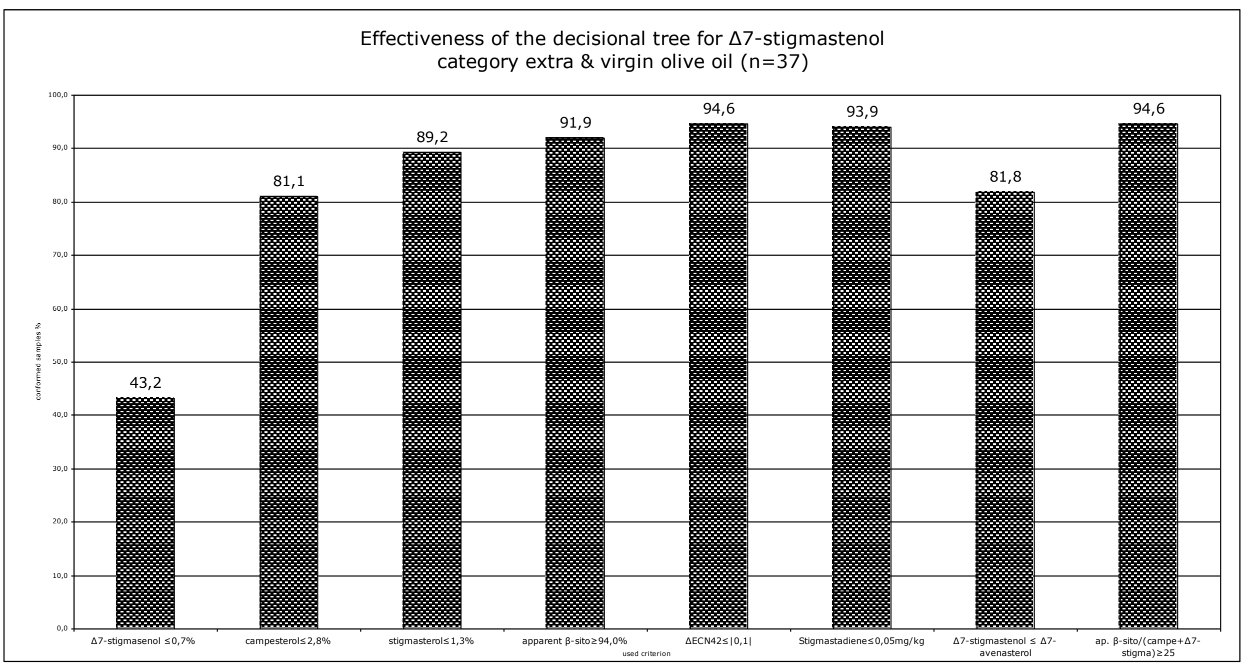
Hence, the decision tree for 0.5%< Δ7–stigmastenol ≤ 0.7% or 0.8%, could include stigmasterol ≤1.4%, stigmastadiene ≤0.05mg/kg, campesterol≤3.3%, apparent β-sitosterol ≥94.0% and ΔECN42 ≤|0.1|, provided all the other purity criteria lie within the established limits.

B. <u>Application of the decision tree to the deviant samples analysed</u>

B.1. EXTRA VIRGIN AND VIRGIN OLIVE OIL

Statistical data on samples deviating from the Δ7-stigmastenol limit

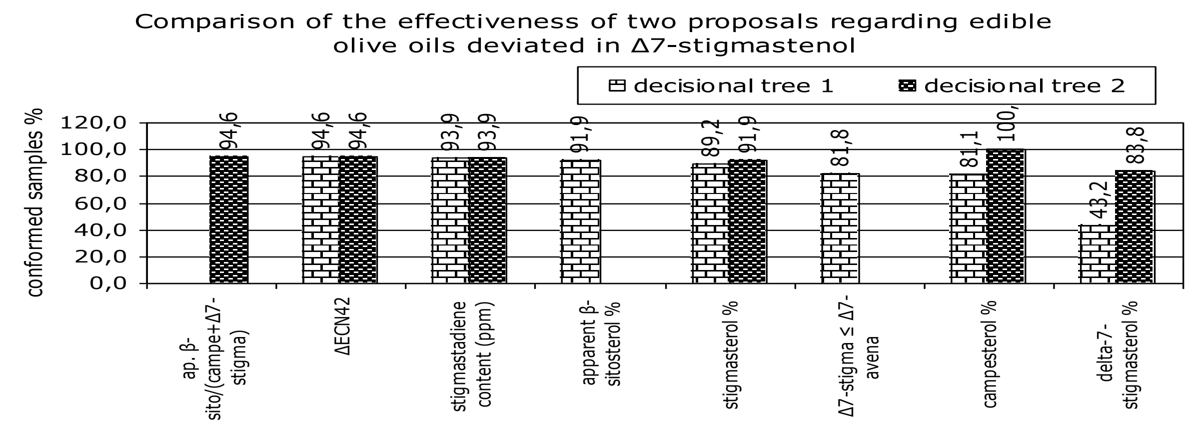
EXTRA VIRGIN & VIRGIN OLIVE OILS (n=37)	Mean	Min	Max	Range	Decision tree
stigmastadiene content (mg/kg)	0.02	0.01	0.06	0.05	≤0.05
campesterol %	2.6	1.9	3.3	1.4	≤2.8 or 3.3
stigmasterol %	1.0	0.3	2.5	2.2	≤1.3 or 1.4
Δ7-stigmastenol %	0.8	0.6	1.2	0.7	≤0.7 or 0.8
apparent β-sitosterol %	94.4	93.0	95.4	2.4	≥94.0
Δ7-stigma ≤ Δ7-avena	81.8% yes				
ap. β-sito/(campe+Δ7-stigma)	29	22	34	12	≥25
C18:2 linoleic acid %	11.9	6.6	18.2	11.6	≤21.0
ΔECN42 (absolute value)	0.0	0.0	0.2	0.2	≤0.1



Since the above decision tree (Δ7-stigmastenol≤0.7%) covers only 43.2% of the deviant samples tested, another decision tree was applied. The following table and chart report the results on comparing the effectiveness of the two decision trees in samples with deviant Δ7-stigmastenol content.

Effectiveness of the decision trees on samples deviating from the Δ7-stigmastenol limit

Category: extra virgin & virgin olive oils	Decision tree 1		Decision tree 2	
	Limits	Conformity %	Limits	Conformity %
campesterol %	≤2.8	81.1	≤3.3	100.0
ap. β-sito/(campe+Δ7-stigma)			≥25	94.6
ΔECN42 (absolute value)	≤0.1	94.6	≤0.1	94.6
stigmastadiene content (mg/kg)	≤0.05	93.9	≤0.05	93.9
stigmasterol %	≤1.3	89.2	≤1.4	91.9
Δ7-stigmastenol %	≤0.7	43.2	≤0.8	83.8
apparent β-sitosterol %	≥94.0	91.9		
Δ7-stigma ≤ Δ7-avena	yes	81.8		



used criteria

Decisional tree 1 :
Δ7-stigmasenol ≤0,7%, campesterol≤2,8%, stigmasterol≤1,3%, apparent β-sito≥94,0%, ΔECN42≤|0,1|, stigmastadiene≤0,05mg/kg, Δ7-stigmastenol ≤ Δ7-avenasterol

Decisional tree 2 :
Δ7-stigmasenol ≤0,8%, campesterol≤3,3%, stigmasterol≤1,4%, ΔECN42≤|0,1|, stigmastadiene≤0,05mg/kg, apparent β-sito/(campe+Δ7-stigma)≥25

CONCLUSIONS:

- The application of the new apparent β-sitosterol/(campe+Δ7-stigma) parameter at a limit ≥25 is more suitable than apparent β-sitosterol since it covers 94.6% of the deviant samples compared with 91.6%. This new parameter can therefore replace apparent β-sitosterol.
- The limit of ≤0.7% for Δ7-stigmastenol is useless because it covers only 43.2% of the deviant samples. In contrast, the limit of ≤0.8% for Δ7-stigmastenol covered 83.8% of the samples.

In the light of these findings, the decision tree for samples of olive oils belonging to the extra virgin and virgin categories exhibiting **0.5% < Δ7-stigmastenol ≤0.8%** could include: campesterol≤3.3%, apparent β-sito/(campe+Δ7-stigma)≥25, ΔECN42≤|0.1|, stigmasterol≤1.4%, stigmastadiene≤0.05 mg/kg. This covers about 83.8% of the deviant samples tested.

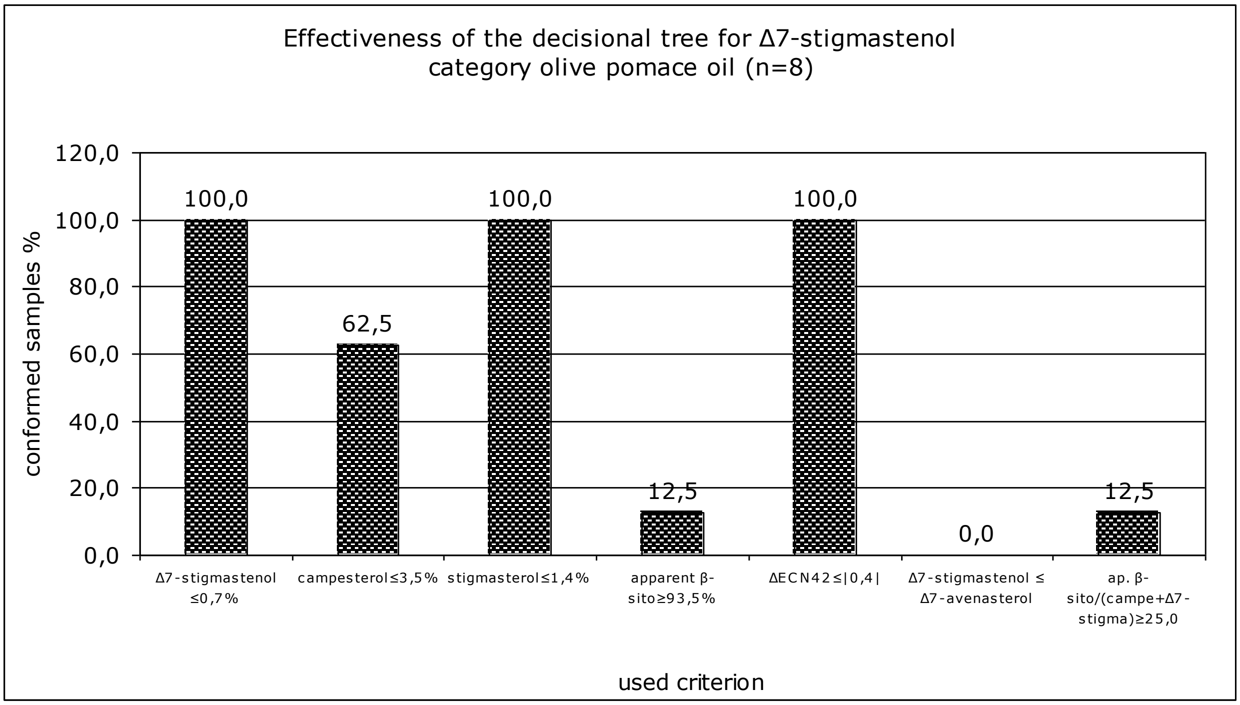
B.2. OLIVE POMACE OIL

Statistical data on samples deviating from the Δ7-stigmastenol limit

OLIVE POMACE OILS (n=8)	Mean	Min	Max	Range	Decision tree
Δ7-stigmastenol %	0.6	0.6	0.7	0.1	≤0.7
campesterol %	3.5	3.3	3.8	0.5	≤3.5
stigmasterol %	1.2	0.9	1.4	0.5	≤1.3
ap. β-sitosterol%	93.2	92.8	93.5	0.7	≥93.5
ΔECN42 (absolute value)	0.2	0.1	0.4	0.3	≤0.4
Δ7-stigmastenol ≤ Δ7-avenasterol	No				
ap. β-sito/(campe+Δ7-stigma)	23	22	26	5	≥25

Effectiveness of the decision tree on samples deviating from the Δ7-stigmastenol limit

Category: olive pomace oils	Decision tree	
	Limits	Conformity %
Δ7-stigmastenol %	≤0.7	100.0
stigmasterol %	≤1.4	100.0
ΔECN42 (absolute value)	≤0.4	100.0
campesterol %	≤3.5	62.5
ap. β-sitosterol %	≥93.5	12.5
ap. β-sito/(campe+Δ7-stigma)	≥25	12.5
Δ7-stigmastenol ≤ Δ7-avenasterol	yes	0.0



CONCLUSIONS:

- The application of the new ap. β-sitosterol/(campe+Δ7-stigma) parameter at a limit ≥25 to the deviant samples and of the apparent β-sitosterol parameter at a limit ≥93.5% is useless because they cover only 12.5% of the samples.
- Stigmasterol at a limit ≤1.4% and ΔECN42 at a limit ≤|0.4| are very suitable for the deviated samples analysed because they cover 100% of the samples.
- Campesterol at ≤3.5% is less effective in that it covers 62.5% of the samples.

Based on the above findings, the decision tree for samples of all the categories of olive pomace oils exhibiting **0.5% < Δ7-stigmastenol ≤0.7%** could include: stigmasterol ≤1.4%, ΔECN42≤ |0.4|. This covers 100% of the deviant samples analysed.

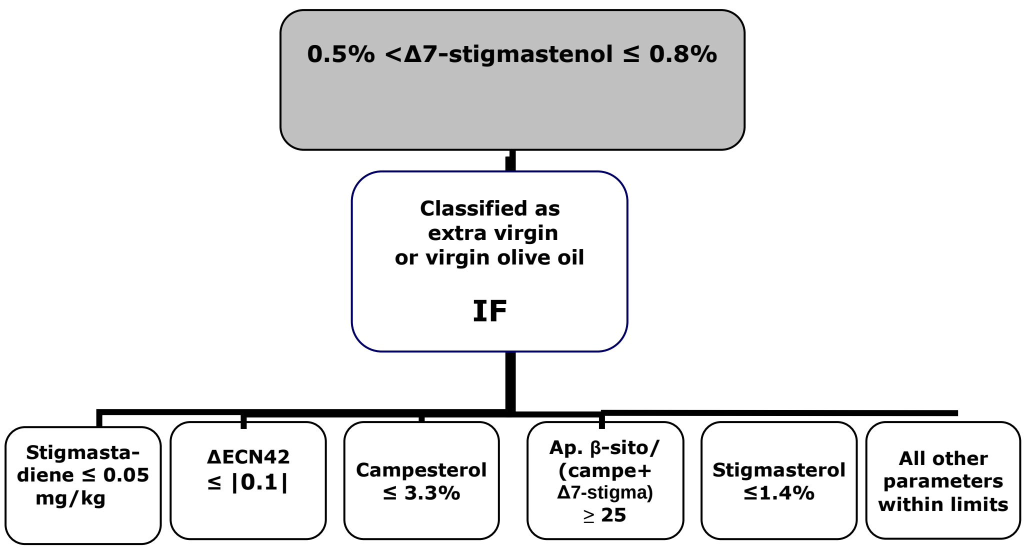
PART 3. PROPOSED DECISION TREES

Based on the conclusions of PART TWO of this report:

	Limits of the oils deviating from IOC/EC limits	IOC/EC limits
Δ7- stigmastenol %		
a) extra virgin olive oil and virgin olive oil		
Δ7-stigmastenol %	**> 0.5 and ≤ 0.8**	≤ 0.5
Campesterol %	≤ **3.3**	≤ 4.0

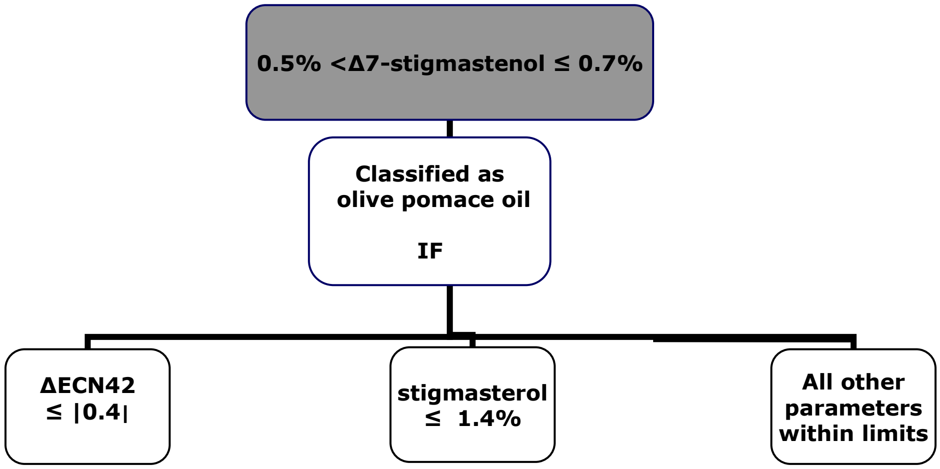
Stigmasterol %	≤ 1.4	≤ campesterol
Apparent β- sitosterol / (campe + Δ7- stigma)	≥ 25	
Stigmastadiene mg/kg	≤ 0.05	≤ 0.05
ΔECN42 (absolute value)	≤ |0.1|	≤ |0.2|
b) olive pomace oil		
Δ7-stigmastenol %	**> 0.5 and ≤ 0.7**	≤ 0.5
Stigmasterol %	≤ 1.4	≤ campesterol
ΔECN42 (absolute value)	≤ |0.4|	≤ |0.6|

3.1. Decision tree for Δ7-stigmastenol in extra virgin and virgin olive oils



In May 2013 the IOC limit for stigmastadiene was changed from 0.10 mg/kg to 0.05 mg/kg for extra virgin and virgin olive oils.

3.2. Decision tree for Δ7-stigmastenol in olive pomace oils.



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