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INNOVHUB-SSOG and ASSITOL joint research project on the use of pomace oil as a substitute of mineral oils in the olive oil production chain

Paolo Bondioli
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Bologna Dec. 13, 2019

SUMMARY

Contamination from hydrocarbons

The presence of mineral oils in vegetable oil is a well known problem

This problem was pointed out when an heavy contamination accident occurred in Ukraine some years ago with sunflower oil.

The continuous improvement of analytical techniques and the increased attention towards food safety stimulated the analytical activity and a growing number of foods were found positive for the presence of this class of contaminants

Contamination from hydrocarbons

Vegetable oils from the market (2000/2005)

	n. samples	positive samples	Min	Max	Mean
soybean oil	4	2	<LQ	20	8
corn oil	8	5	<LQ	33	10
peanut oil	5	5	3	34	10
sunflower oil	10	10	5	53	12
mixseed oil	6	6	6	40	15
grapeseed oil	10	10	22	40	30
extra virgin olive oil	73	10	<LQ	120	4
olive oil	13	13	6	30	14
olive pomace oil	10	10	115	250	137
other vegetable oils	17	14	<LQ	260	37

Moret, Populin, Conte; Riv. Ital. Sost Grasse, 86, 3-14 2009

Olive oil from the market (2014-2015)

- Extra virgin olive oil (40 samples, mean MOSH 8 mg/kg,; only 2 sample with MOAH above LOQ 2 mg/kg))
- Olive oil (16 samples, mean MOSH 18 mg/kg))
- Olive pomace oil (11 samples, mean MOSH 174 mg/kg))

The possible contamination sources

A deep evaluation of possible contamination sources allowed to identify several possible causes:

- Environment (proximity of big traffic routes)
- Agronomic practice, use of petroleum products
- Chain saw lubricants (chainsaw, harvester, shaker)
- Two stroke engines (aerosol fallout)
- Hydraulic devices of agricoltural machines
- Machinery in Olive Oil Mill
- And more ……..

Partnership – The Research Group

Paolo Bondioli, Liliana Folegatti: chemical analysis, field tests,contaminants evaluation, liason with farmers, project management

Igor Calderari: relations with companies, orchards, coordination activity

Luca Lazzeri (CREA – CI) : preparation of amending fluids, field tests, contacts with farmers
Daniele Pochi (CREA – IT): hydraulic fluids – bench tests

Research Targets

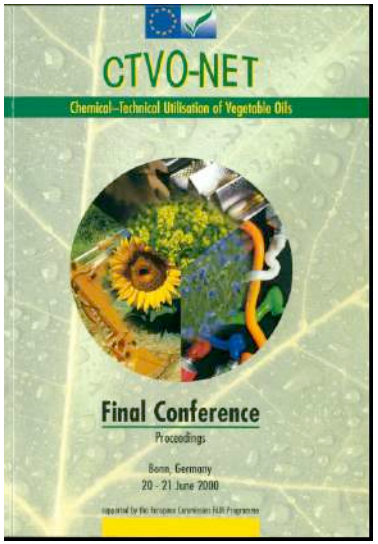
Evaluating and, if possible, solve in toto o in part the problem of mineral oil contamination in olive oils (in all commodity categories)

Suggest renewable biomaterials as substitutes of products of fossile origin
Contributing at circular economy

Find new possible technical uses, if possible with higher added value for olive husk oil

The rationale under the project

Substituting mineral based lube oils with olive husk oil



Lubricants and Hydraulic Fluids

CHAIR

- Paolo Bondioli SSOG - IT
- Amaya Igartua TEKNIKER -SP

- A huge tradition for the substitution of mineral based lubricants with vegetable oils and derivatives still exist
- Under a chemical point of view the two products are very different (hydrocarbons vs. esters)
- Biolubricants can provide a better biodegradability, lubricity, lower viscosity changes with increasing temperature, lower volatility.
- The other side of the moon is that they are more sensitive towards hydrolisis, oxidation, polymeraization and generally have worse cold flow properties

The working programme

1. Orchards selection: thanks to ASSITOL activity 11 orchards have been contacted and a picture of the structure and of the installed machines was taken.

Oliveto n.	1	2	3	4	5	6	7	8	9	10	11
Località	Lamezia Terme CZ	Squillace CZ	Venosa PZ	Squillace CZ	Ostuni BR	Campiglia Marittima LI	Castelnuovo Cilento SA	Ischitella FG	Carpino FG	Sessa Cilento SA	Orria Sa
Superficie a olivi, ha	60	14,30	0,09	2,90	4,83	5,411	30	28,70	0,64	8	120
Numero Piante	10.000	5200	15	320	2500	1897	9000	4800	130	1200	1500
Cultivar	Carolea Frantoio Ogliastro-Leccino	Carolea	Ogliarola del Vulture	Carolea	Leccino	N.D.	FS17 Frantoio	Ogliarola Garganica Leccino Cortina	Ogliarola Garganica	Ogliarola Leccino Frantoio	Leccino Frantio Saleila
Addetti, n°	7	4	1	1	1	1	2	8	2	2	2
Motoseghe	n. 2 motore 2 tempi Stihl	n. 1 motore 2 tempi Stihl	n. 1 motore 2 tempi Castor	n. 1 motore 2 tempi Stihl	n. 1 motore 2 tempi Shindawa	n.1 motore a 2 tempi		n. 2 motore 2 tempi Stihl	n. 2 motore 2 tempi Stihl ECHO	n.2 motore 2 tempi Husquarna Steel	n. 0
Soffiatori/irroratori	n.0	n. 0	n. 0	n.0	n. 0		n. 1 illeggibile	n. 0	n. 0	n. 0	n. 0
Decespugliatori	n. 2 motore 2 tempi Kawasaki Green Line	n. 1 motore 2 tempi Stihl	n. 1 motore 2 tempi Catai	n. 1 motore 2 tempi Jonsered	n. 0		n. 0	n. 0	n. 1 motore 2 tempi Oleo Mac	n. 1 motore ? tempi Castor	n. 0
Motofalciatrice	n. 0	n. 0	n. 0	n. 0	n. 0			n. 0	n. 0	n. 0	n. 0
Abbacchiatore/Scuotitore	n.	n. 2 1 motore 2 T Cifarelli 1 motore 4 T Mamut	n. 1 Elettrico Campagnola	n. 1 motore 2 tempi Cifarelli	n. 0	Pneumatici con lubrificazione a perdere	n. 1 Elettrico	n. 6 Lisam MG Turbo aria compressa con lubrificazione a perdere	n. 4 Lisam Magnesium 1500 con lubrif. a perdere	n. 1 motore 2 tempi Zanon	n. 1 motore 2 tempi Zanon
Macchine con fluidi idraulici	n. 2 scuotitrice raccoglitrice	n. 1 macchina semovente x raccolta olive	n. 0	n. 0	Scuotitore idraulico Verdegiglio su trattore Landini		New Holland TK 80 cingolato	n. 0	n. 0	Trattore NHCTDK Trattore Powerstar	n. 2 Trattore SAME con pala meccanica
Scuotitore	n.1 motore 2 tempi Cifarelli	n. 0	n. 0	n. 0	n. 0		n. 0	n. 0	Motocompressore Yanmar a gasolio Compressore	n. 0	n. 0
Altro								Motocompressore Airmec con lubrificazione a perdere	Campagnola n. 2 forbici pneumatiche Campagnola Lysam	n. 0	

The working programme

2. Each plantation (8 out 11) delivered 10 kg of olives to INNOVHUB. The received fruits were processed in or lab to obtain olive oil, by avoiding possible contamination in transportation and processing along the industrial production chain

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Screw Crusher

Malaxer

Press

The working programme

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3. The obtained oils will be then analyzed for their MOSH and MOAH contamination. We hope to find 4-6 orchards where contamination could be evident. On this group the further activity will be carried out. Results are expected within the end of Jan., 2020

Olive Husk Oil Properties

• Acidity	0,18 % oleic acid
• Kinematic viscosity @ 40 °C	40,12 mm^2/sec
• Kinematic viscosity @ 100 °C	8,52 mm^2/sec
• Viscosity Index	197
• Copper corrosion (50 °C, 3 hours)	1°
• Rancimat Induction Time (120 °C)	6,62 hours
• Monoglycerides content	0,29% m/m
• Diglycerides content	5,90 % m/m
• Sulphur	7,6 mg/kg
• Phosphorous	0,3 mg/kg
• All other metal contaminants	< 0,3 mg/kg
• Pour Point	-9 °C
• Slip Point(*)	-3 °C
• Limpidity Point(*)	0 °C

(*) literature data

The working programme

Starting from January 2020 all lubricants in use in the selected orchards will be substitued with Refined Olive Husk Oil, in:

- Two stroke engines
- Chain saw
- Lost lubricants

- For the time being the tests for hydraulic fluid will be carried out on a special experimental device located near CREA IT, Monterotondo

The working programme – Evaluation of obtained effects

The sampling procedure will be repeated during the 2020-2021 olive oil campaign: olive samples will be collected, extracted in the lab and analyzed for their mineral oil contamination levels.

At the same time all machinery used for the tests will be delivered to the manufacturer in order to evaluate the impact of the use of Olive Husk Oil instead of mineral oil lubricant.

OLIVE HUSK OIL AS A LUBRICANT FOR TWO STROKE ENGINES - 1

Two stroke engines, both operating with pre-formed mixture or with separate lubrication tools discharge in the environment important amount of unburned hydrocarbons as exaust.

Mineral or synthetic (hydrocarbon) oils are normally in use for lubrication.

The exaust delivery in form of aerosol may have a strong impact on orchards.

Many lubricants are actually available for two stroke engines in a very large range of viscosities

OLIVE HUSK OIL AS A LUBRICANT FOR TWO STROKE ENGINES - 2

The use of vegetabile oils for lubrication of two strokes engines began many years ago with castor oil

One of the key factors in lubrication is represented by the interaction between lubricant and metallic surface, that promotes the formation and the integrity of the liquid fillm existing between piston and cylinder. In this case vegetale oils, thanks to their higher polarity provide better performances.

Problems can occur from a different cold behaviour, from Conradson Carbon Residue and from polymer formation in different engine sections

OLIVE HUSK OIL AS A LUBRICANT FOR TWO STROKE ENGINES - 3

Primary materials in 2-cycle oil formulations:

1) Base Oil- Mineral oil or synthetic oil but not including polybutenes.

2) Additives- To improve lubricity and detergency. detergents, dispers ants, anti-wear agents, EP agents.

3) Polybutenes- To improve reduction of exhaust smoke.

4) Distillates - to improve handling and fuel miscibility distillates are added such as kerosene, gas oils, or other solvents.

OLIVE HUSK OIL AS A LUBRICANT FOR TWO STROKE ENGINES - 4

Marca	Prezzo USD/kg	Olio Base	Viscosità @ 40 °C, mm2/sec	Viscosità @ 100 °C, mm2/sec	Indice Viscosità
PJ1	20	1 + 2	42	7,1	128
Putoline	17	4	33,7	7	153
Spectro	11,5	1 + 2	77,1	9,4	97,6
Yamaha	10	1 + 2	55	8,5	126
Amalie	5	2	55	8,5	126
Motul 510	12	1 + 2	66,5	8,2	126
Motul Scooter	12	1 + 2 + 4	56,2	9,1	142
Lucas	11,5	1 + 4	41,5	7,5	149
AMSoil	13	1 + 5	36,6	7,2	165
Bel Ray	18	5	141	12,2	72
Olio di Sansa	?	"5"	38 – 42	8 – 9	> 190

There are 5 groups of oils: 1. refined petroleum oil, 2. moderately refined petroleum oil, 3. highly refined petroleum oil, 4. PAO synthetic oil, 5. ester synthetic oil.

Results of the first test on two strokes engine

The first test on two strokes engine

The only real mistake is that from which we learn nothing

OLIVE HUSK OIL AS A CHAIN SAW LUBRICANT - 1

Lubricants to be used with chainsaw, pruning, cleaning and olive harvesting belong to the category of lost lubricants and represent a big souce of environmental pullution.

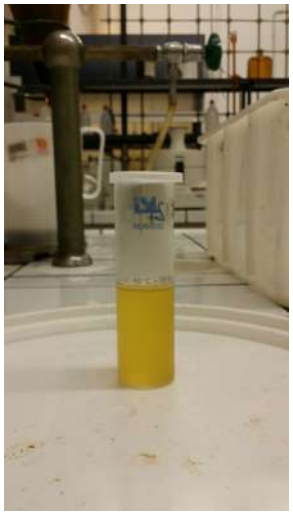
As lost lubricants a strong resistance during use is not required

Actually on the market several biodegradable products, based on used frying oils ara available.

The market price is generally low and this fact can represent a barrier for the use of olive husk oil.

Sometimes these «biodegradable oils» are contaminated with mineral oils.

OLIVE HUSK OIL AS A CHAIN SAW LUBRICANT - 2



The substitution in this case should not represent a problem, except for:

- Market price
- Cold stability

To solve the problem of selling price crude olive husk oil could be used but:

- Greater stability problems due to the high content of free fatty acids
- Corrosion issues for the same reason

OLIVE HUSK OIL AS A CHAIN SAW LUBRICANT - 3

Loss Lubrication Oils			
MOGUL	**ISO VG**	**Product Specification**	**Performance classes, Specifications Level**
ALFA HOBBY	100	Chain-saw oil with very good protection against wear, suitable for all loss-lubrication applications in high-load chains, pins, joints, pressure and guiding elements, etc. operating under high load. The product provides special adhesive properties.	
ALFA BIO	46, 68	Biologically degradable oils designed for lubrication of chainsaws, with high protection against wear. The product complies with the Act 289/95 Coll. ("Forest Act") and provides a special adhesive properties	

OLIVE HUSK OIL AS AN HYDRAULIC FLUID- 1

Hydraulic fluids are in use in circuits for the transmission of power and movement.

The use of biodegradable fluids based on natural oils and derivatives are well known and already in use.

In this case, in addition to the rewarding lubricity properties and high viscosity index and the negative ones in terms of instability to cold, oxidation and hydrolysis, the «fire resistant» feature is also interesting

The hydraulic fluid based on refined pomace oil will be tested in a test bench simulating the exercise in the field by applying working conditions capable of accelerating aging.
It has been estimated that 150 hours of work in these conditions mimic one year in field work.

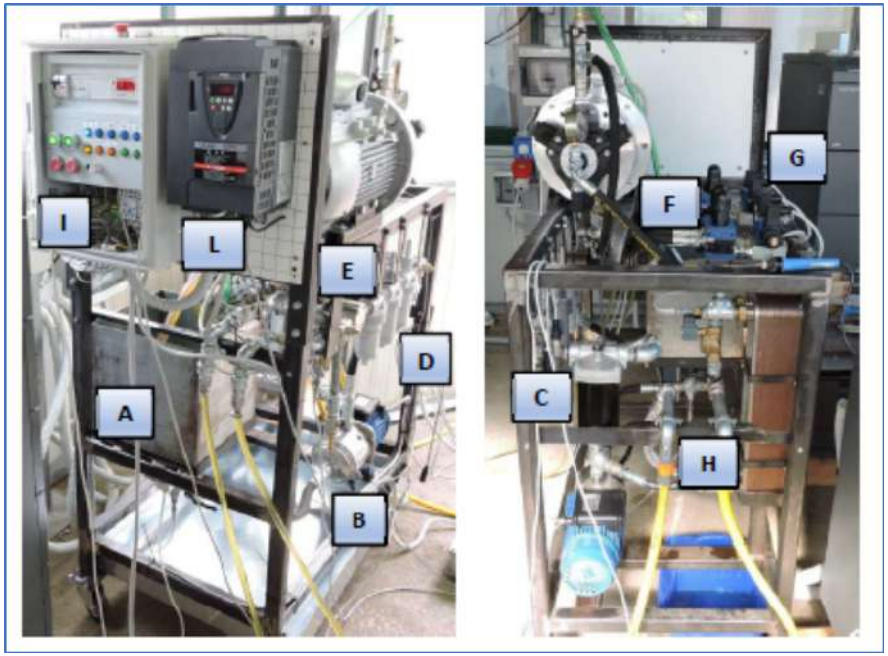
OLIVE HUSK OIL AS A HYDRAULIC FLUID- 2

On the right: the test bench of CREA-IT for tests on hydraulic and powertrain fluids of renewable origin.

A comparison of performances is carried out using reference mineral fluids

The operative parameters in the different bench sections, such as operating pressure, flow rate, rotating speed, temperature) are under continuous monitoring. If variations are recorded they can be attributed to oil degradation.

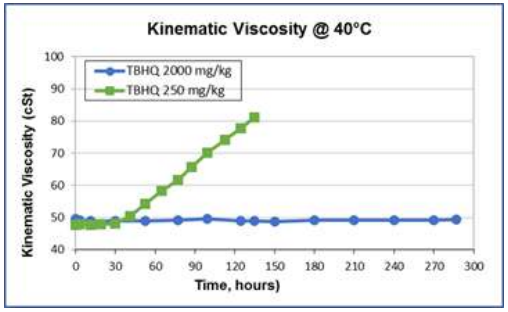
In parallel also the behaviour of the oil in terms of main chemical-physical parameters (viscosity, acidity, peroxyde value) is recorded during test.

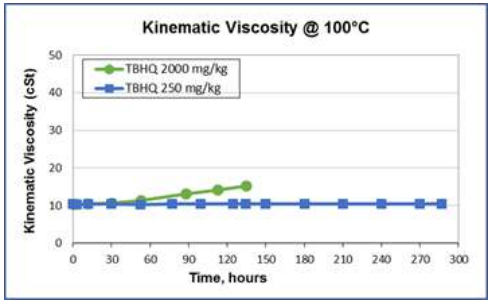


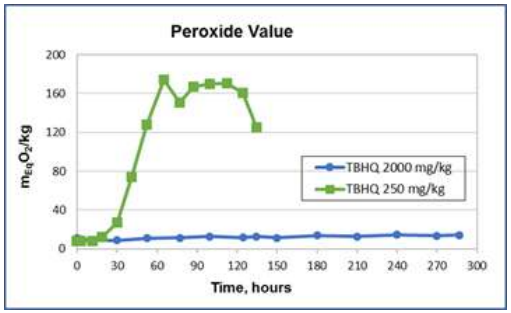
Views of the OTR. A) fluid reservoir (30 dm³ capacity); B) low pressure circulation pump (max pressure 0.5 MPa); C) main filter (25 µm class diameter); D) three-stage filter system (3, 6, 10 µm class diameter) and bypass; E) oval gears flow rate; F) high-pressure piston pump (max pressure 50 MPa); G) distributor block with 4 solenoid valves and 4 pressure valves (10, 20, 30, 40 MPa); H) oil-to-water heat exchanger; I) electronic control and command module; L) inverter operating the high-pressure pump

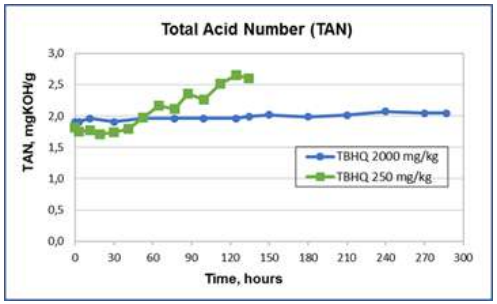
OLIVE HUSK OIL AS AN HYDRAULIC FLUID- AGROENER PROJECT

Changes in appearence for oil samples during the 150/280 h test
(results from AGROENER Research Project)





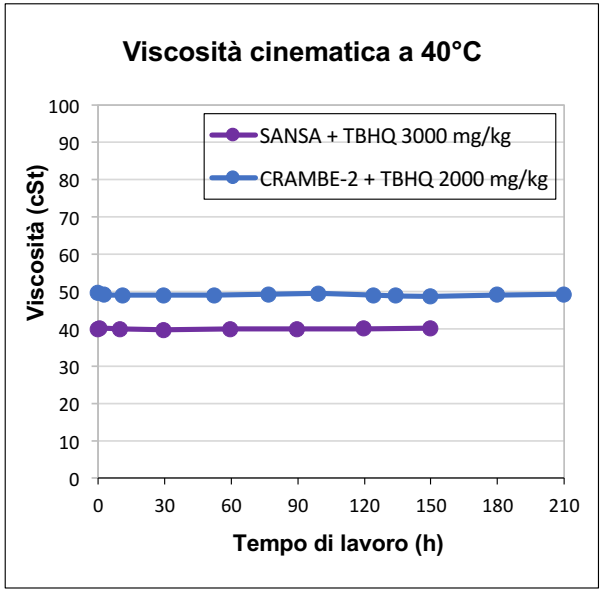


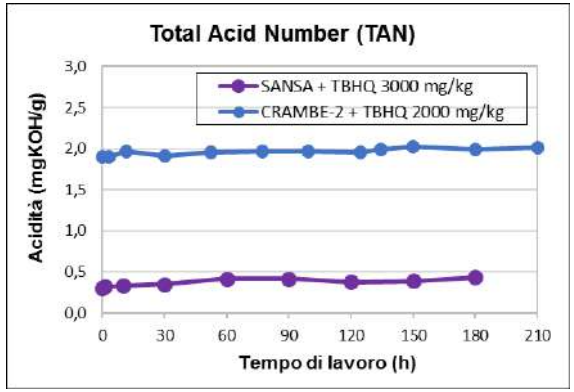


Changes in Viscosity, Peroxide Value and Acid Value recorded during a test carried out with Crambe abyssinica oil at two different antioxidant concentrations.

(results from AGROENER Research Project)

Behaviour of Olive Husk Oil in comparison with Crambe abyssinica oil





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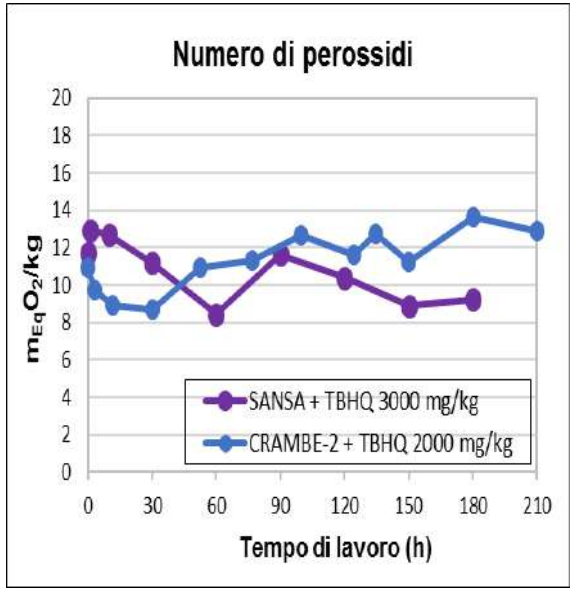


Bio Fumigants for pests treatment

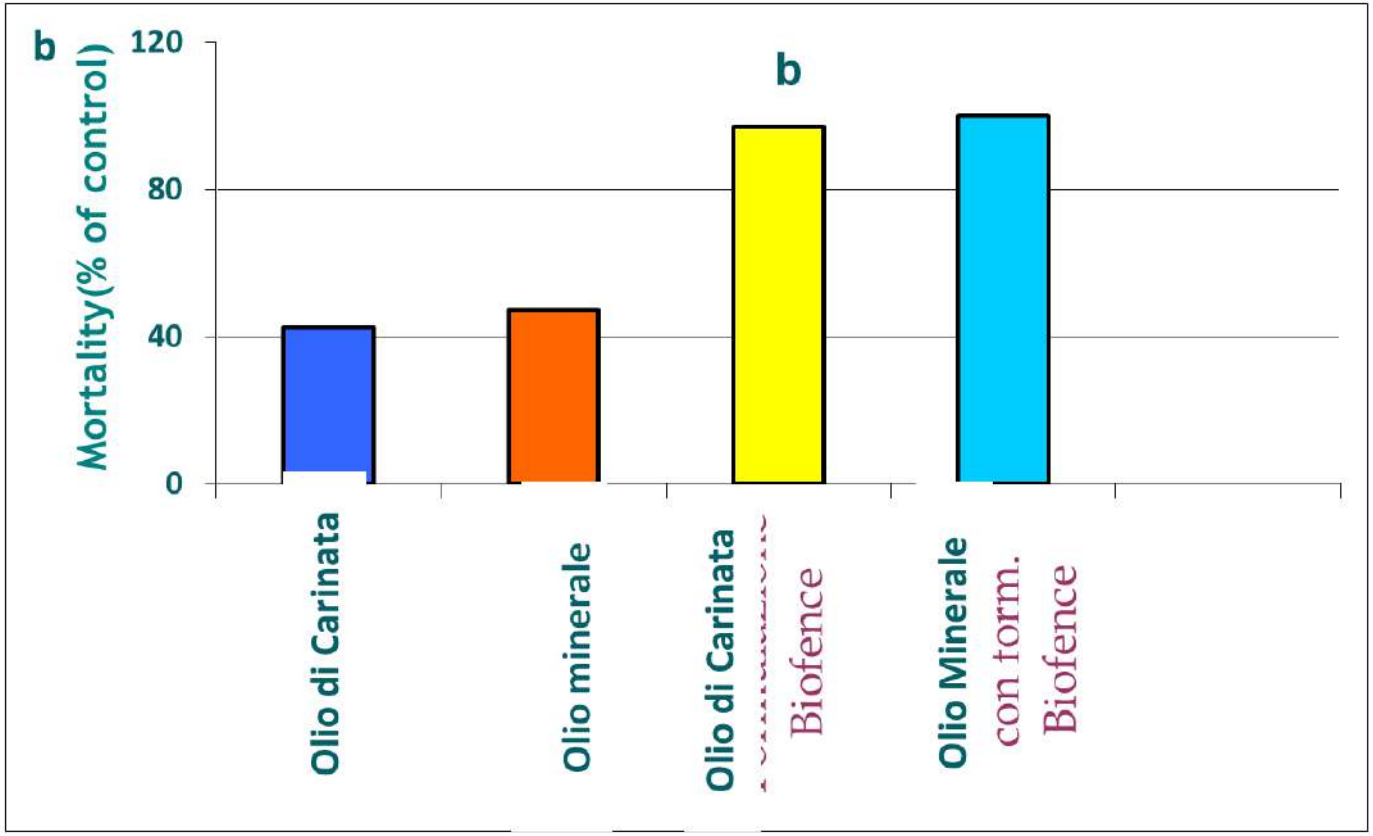
Fluids for leaves
PCT W
2006/136933 A2

Bio Fumigants for pests treatment

- In fact the possibility to use these Bio Fluids in the treatment of pests on olive trees is limited to Cocciniglia mezzo grano di pepe (Saissetia oleae)

- Notwithstanding this fact it very interesting to suggest the test Olive Husk Oil as a solvent for all crops and trees that can be treated by spraying fluids

Effect of liquid products on cochineal (*Aonidiella aurantii* M.)



THE ECONOMIC POINT OF VIEW

In order to have a rough idea of the possibility for a market success of this new product, provided that its suitability for use will be demonstrated,we must consider the market prices of the actual competitors

Retail prices in 1-5 litri package

Two stroke oils:	5 – 10 Euro/litre
Chain saw oils:	3 – 20 Euro /litre
Hydraulic fluids:	3 - 5 Euro/litre

THE ECONOMIC POINT OF VIEW

Less encouraging is the bulk price

200 litres drum

Two stroke engines	not available
Chain saw oils:	1,1 Euro /litro
Hydraulic fluids:	3 – 3,5 Euro/litro

The prices of olive husk oil, in bulk are approx.:

- Crude 0,70 Euro/kg
- Refined 1,15 Euro/kg

The limits of our project

- The olive husk oil has well defined properties that cannot be modified.
- Some properties (oxistab, cold flow, viscosity) could be modified by means of additives
- Using additives could solve some problem **NOW**, but could create problems **TOMORROW**, perhaps introducing new contaminants in the oils and in the environment as well.

THE TECHNICAL POINT OF VIEW

Property	Hydraulic Fluid	Chain Saw	2 strokes
Viscosity	**OK**	**OK**	**OK**
Viscosity index	**OK**	**OK**	**OK**
Cold stability	**NO**	**NO**	**NO**
Hydrolitic stability	non problematic	non problematic	non problematic
Oxidation stability	**Problematic**	non problematic	**Problematic**
Formation of solid residues (lacquer and glue)	**Problematic**	**Problematic**	**Problematic**
Carbon residue formation	non problematic	non problematic	**Very problematic**
Corrosion tendency (Crude oil)	**NO**	**NO**	**NO**
Corrosion tendency (Refined oil)	**OK**	**OK**	**OK**
Lubricity	**OK**	**OK**	**OK**
Elastomers compatibility	**To be assessed**	**To be assessed**	**OK (problems with separated systems?)**
Operating life	**Lower**	**OK**	**OK**
Manufacturer warranty	**Problematic**	**Problematic**	**Problematic**
Selling price	**NO**	**NO**	**OK**

CONCLUSIONS

What we are facing is a research project and as such it is not destined for sure success

Some time analyzing the initiative critically was spent, but unforeseen problems could emerge once we are on the field

The proposed technical substitutions have different success possibilities.

The impact that each of them should have on oil contamination is also different

THANK YOU FOR YOUR ATTENTION

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Innovation and research

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