

SUPPLEMENTARY MATERIAL

**Quality and nutritional changes of traditional cupcakes in the
processing and storage as a result of sunflower oil
replacements with refined olive pomace oil**



SUPPLEMENTARY METHODS

Method S1 Analysis of volatiles

Hexanal was quantitatively analysed by SPME-GC-MS. One gram of cupcake sample, crumbled by gloved hands, was placed on to a 20-mL vial that was hermetically sealed with a silicone/PTFE septum. The sample was conditioned at 40 °C for 15 min. A Divinylbenzene/Carboxen/Polydimethylsiloxane (DVB/CAR/PDMS) SPME fibre (Supelco, Bellefonte, PA, USA) was inserted in the vial. The sampling time was 30 min at the same temperature. Then the volatiles were analysed in an Agilent 6890 chromatograph (Agilent Technologies, Inc.) equipped with a split-splitless injector, an Agilent J&W DB-WAX capillary column (60 m × 0.25 mm × 0.25 µm) (Agilent Technologies, Inc.) and a 5975C Mass Spectrometer Detector (Agilent Technologies, Inc.). The injector temperature was 250 °C and 0.1:1 split ratio was used. The initial oven temperature was 50 °C (5 min) then it was increased at 4 °C min⁻¹ up to 100 °C (0 min) and at 17 °C min⁻¹ to 220 °C (10 min). Hydrogen at 1 mL min⁻¹ was the carrier gas. The GC-MS interface operated at 280 °C, the actual MS source temperature was 230 °C and that of the MS quadrupole was 150 °C. The electron impact energy was set at 70 eV and scans in the range 25.00-450.00 a.m.u. were recorded. For quantification purposes, the area under the curve of the total ion current was used and external calibration was applied. Towards this end, an amount of 100 mg of solutions of hexanal in medium chain triacylglycerols (MCT oil), pure C8 MCT oil (Ketosource Ltd., England), in the concentration range of 0.5-20.0 µg g⁻¹, was added to 1 g of fresh SO cupcake sample, previously crumbled. The samples containing hexanal were analysed as described above. A linear calibration curve was obtained for each day of analyses.

Along with hexanal other volatiles were also evaluated on the GC-MS chromatograms. They were tentatively identified using NIST 08 mass spectral library.

SUPPLEMENTARY FIGURES

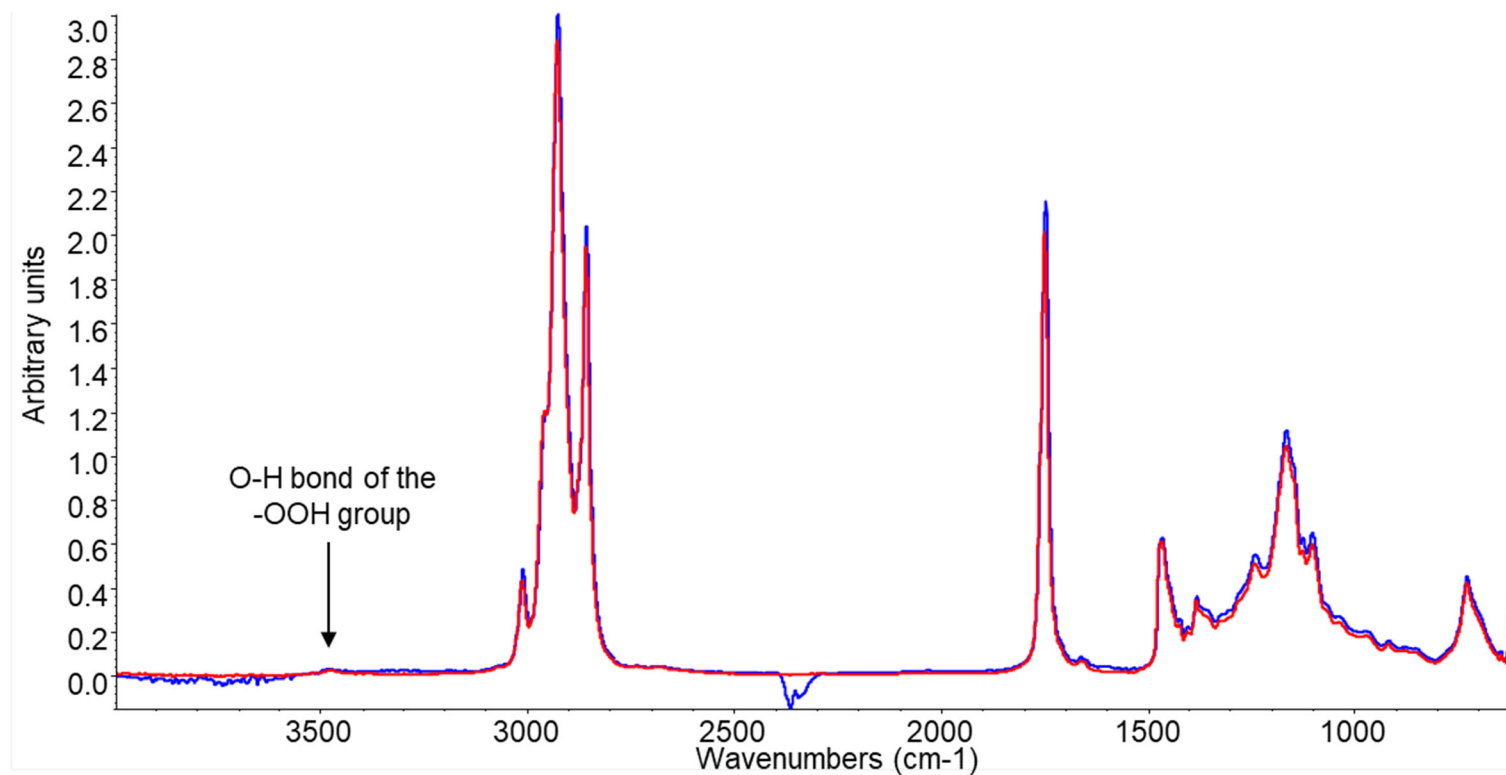


Figure S1 ATR-FTIR spectra of the fat extract obtained from the batter (red) of SO-1 sample and the corresponding sunflower oil (blue).

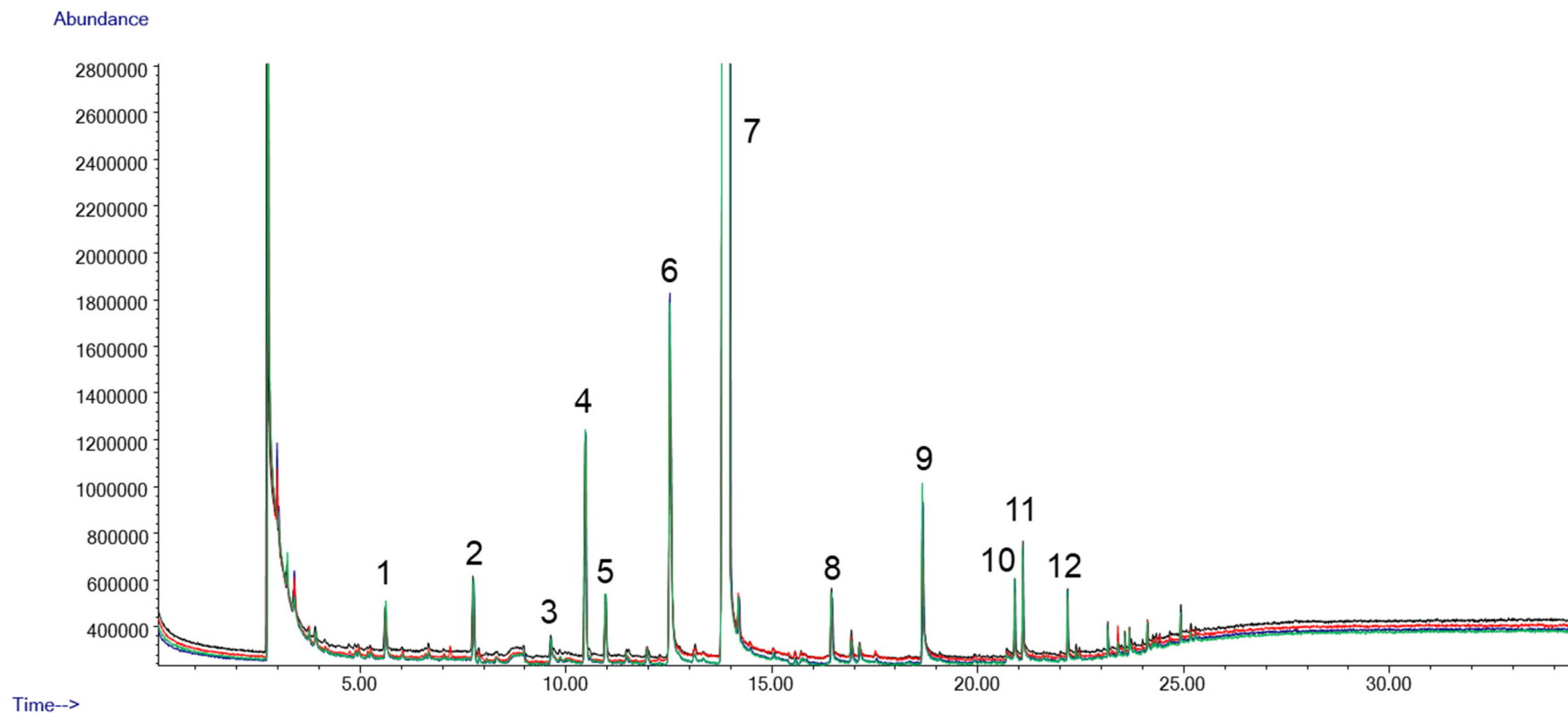


Figure S2 GC-MS chromatograms of fresh samples of SO-1 (black), OPO25-1 (blue), OPO50-1 (green) and OPO-1 (red) cupcakes. Tentatively peak assignment: Ethanol (1), α -pinene (2), unknown compound overlapping with hexanal (3), sabinene (4), 3-carene (5), β -pinene (6), D-limonene (7), 1-methyl-3-isopropylbenzene (8), 6-methyl-5-heptene-2-one (9), 1,5-dimethyl-1,5-cyclooctadiene (10), 1-methyl-4-isopropylcyclohexene (11) and 2,6-dimethyl-1,5,7-octatriene (12).

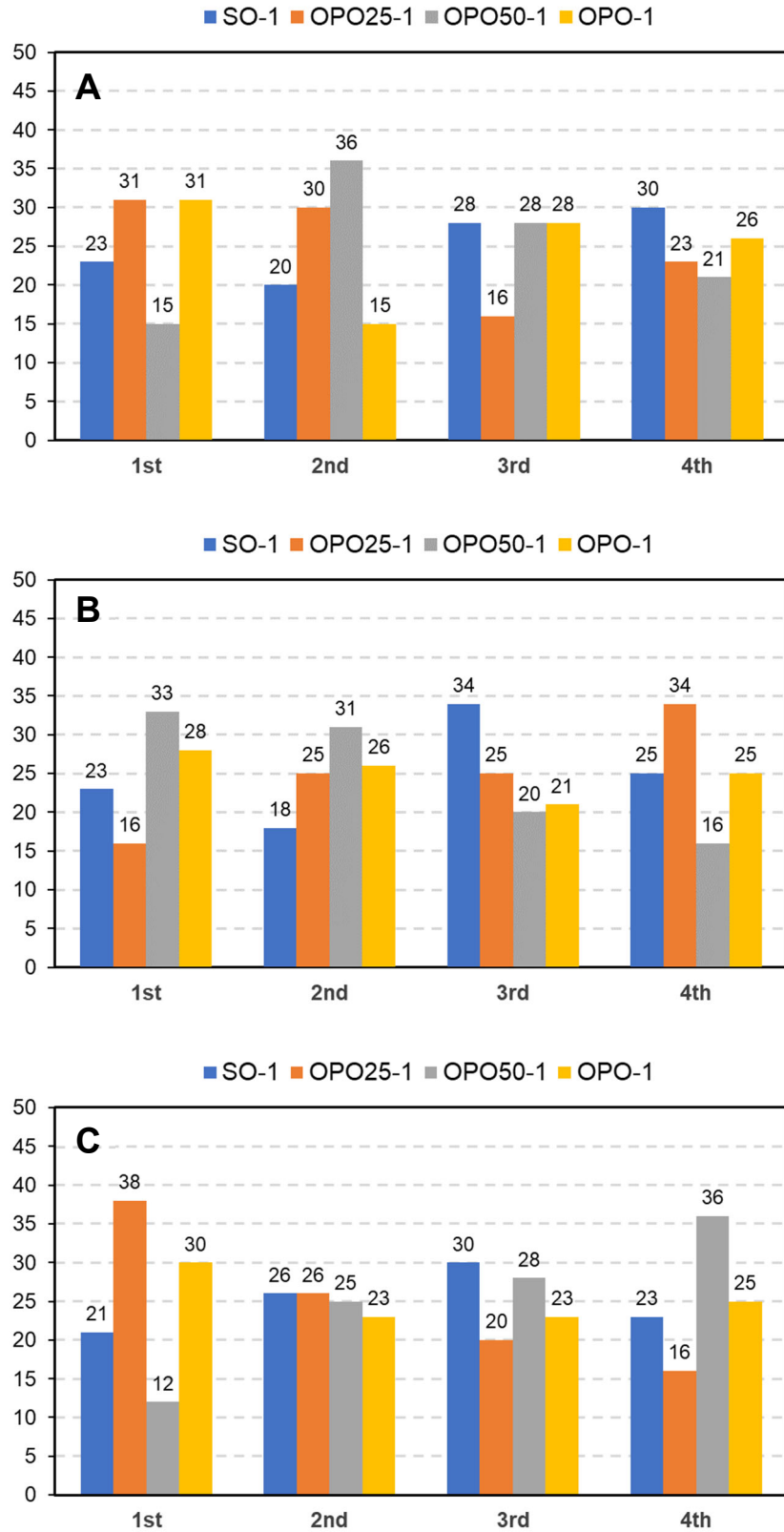


Figure S3 Consumer preference tests on fresh cupcakes (A) and cupcakes after 3-month (B) and 6-month storage (C). Results represent the percentage of panellists (n=61).

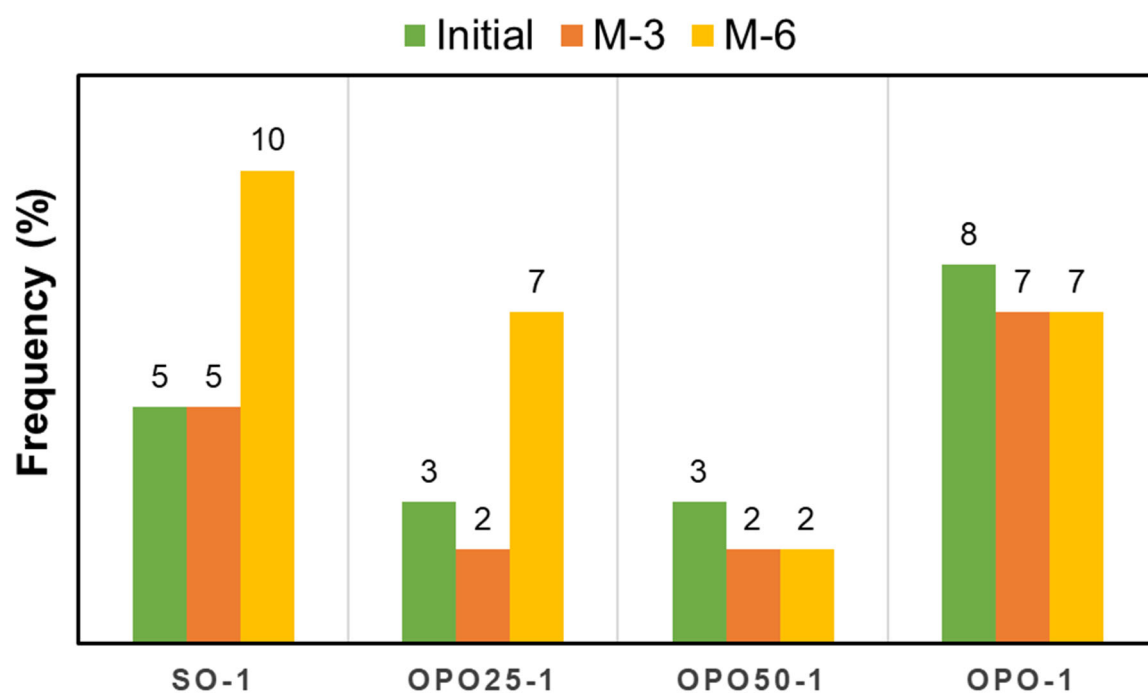


Figure S4 Percentage of consumers indicating rancid odour or taste characteristic of seed oils or nuts in the fresh cakes (Initial), and samples stored for 3 (M-3) and 6 months (6-M). Results represent the percentage of panellists (n=61).

SUPPLEMENTARY TABLES

Table S1 Fatty acid compositions (%) of the oils.

	SO-1	SO-2	SO-3	OPO-1	OPO-2	OPO-3
C16:0	6.16 ± 0.02	6.15 ± 0.01	6.38 ± 0.01	12.19 ± 0.01	12.11 ± 0.01	12.50 ± 0.01
C16:1	0.12 ± 0.00	0.12 ± 0.00	0.13 ± 0.02	0.93 ± 0.00	0.96 ± 0.01	0.95 ± 0.00
C18:0	3.58 ± 0.00	3.57 ± 0.00	3.56 ± 0.01	2.53 ± 0.00	2.58 ± 0.04	2.39 ± 0.01
C18:1	37.90 ± 0.14	38.00 ± 0.03	32.31 ± 0.11	71.51 ± 0.02	71.51 ± 0.07	70.51 ± 0.03
C18:2	50.42 ± 0.13	50.27 ± 0.00	55.87 ± 0.10	10.74 ± 0.02	10.67 ± 0.01	10.98 ± 0.01
C18:3	0.08 ± 0.00	0.08 ± 0.00	0.07 ± 0.01	0.62 ± 0.01	0.61 ± 0.00	0.59 ± 0.01
C20:0	0.24 ± 0.00	0.25 ± 0.01	0.23 ± 0.01	0.39 ± 0.01	0.40 ± 0.01	0.42 ± 0.00
C20:1	0.15 ± 0.00	0.16 ± 0.01	0.14 ± 0.00	0.32 ± 0.00	0.31 ± 0.00	0.32 ± 0.00
C22:0	0.70 ± 0.00	0.71 ± 0.00	0.67 ± 0.01	0.17 ± 0.01	0.18 ± 0.02	0.18 ± 0.00
C18:1t	nd	nd	nd	0.22 ± 0.00	0.21 ± 0.00	0.22 ± 0.00
C18:2t	0.34 ± 0.01	0.34 ± 0.00	0.32 ± 0.01	0.12 ± 0.01	0.14 ± 0.08	0.15 ± 0.01
C18:3t	nd	nd	nd	0.04 ± 0.00	nd	0.04 ± 0.00
ΣAG <i>trans</i>	0.34 ± 0.01	0.34 ± 0.00	0.36 ± 0.01	0.17 ± 0.01	0.35 ± 0.02	0.41 ± 0.01

SO, sunflower oil; OPO, olive pomace oil; OPO25, a blend of SO and OPO containing 25 wt% OPO; OPO50, a blend of SO and OPO containing 50 wt% OPO; nd, not detected. Results represent the mean followed by the standard deviation of 3 analytical determinations (n=3).

Table S2 Fatty acid compositions (%) of the oil blends.

	OPO25-1	OPO25-2	OPO25-3	OPO50-1	OPO50-2	OPO50-3
C16:0	7.81 ± 0.09	7.62 ± 0.03	8.02 ± 0.16	9.35 ± 0.12	9.10 ± 0.10	9.39 ± 0.04
C16:1	0.31 ± 0.01	0.30 ± 0.00	0.34 ± 0.01	0.50 ± 0.01	0.50 ± 0.01	0.55 ± 0.00
C18:0	3.34 ± 0.01	3.33 ± 0.01	3.29 ± 0.01	3.05 ± 0.01	3.08 ± 0.00	2.99 ± 0.01
C18:1	46.42 ± 0.17	46.08 ± 0.07	42.04 ± 0.25	55.50 ± 0.35	54.75 ± 0.36	51.42 ± 0.10
C18:2	39.97 ± 0.28	40.54 ± 0.09	44.51 ± 0.37	29.45 ± 0.52	30.52 ± 0.37	33.70 ± 0.14
C18:3	0.24 ± 0.01	0.23 ± 0.01	0.22 ± 0.01	0.38 ± 0.01	0.35 ± 0.01	0.33 ± 0.00
C20:0	0.31 ± 0.02	0.33 ± 0.00	0.30 ± 0.02	0.38 ± 0.01	0.38 ± 0.00	0.36 ± 0.00
C20:1	0.20 ± 0.00	0.20 ± 0.00	0.18 ± 0.00	0.23 ± 0.00	0.22 ± 0.01	0.22 ± 0.00
C22:0	0.58 ± 0.02	0.60 ± 0.00	0.55 ± 0.03	0.40 ± 0.02	0.71 ± 0.00	0.67 ± 0.01
C18:1t	0.13 ± 0.02	0.10 ± 0.00	0.06 ± 0.06	0.19 ± 0.03	0.14 ± 0.02	0.13 ± 0.01
C18:2t	0.28 ± 0.03	0.29 ± 0.01	0.29 ± 0.01	0.23 ± 0.01	0.23 ± 0.00	0.23 ± 0.01
C18:3t	nd	nd	nd	0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.00
ΣAG <i>trans</i>	0.41 ± 0.04	0.40 ± 0.01	0.35 ± 0.05	0.42 ± 0.02	0.39 ± 0.01	0.37 ± 0.01

nd, not detected. Results represent the mean followed by the standard deviation of 3 analytical determinations (n=3).

Table S3 Quality parameters of the oils.

	SO-1	SO-2	SO-3	OPO-1	OPO-2	OPO-3
Acidity (%)	0.11 ± 0.000	0.11 ± 0.000	0.08 ± 0.002	0.08 ± 0.000	0.08 ± 0.000	0.07 ± 0.000
PV (meq/kg)	3.58 ± 0.06	3.29 ± 0.03	10.7 ± 0.1	3.79 ± 0.03	2.97 ± 0.04	1.86 ± 0.05
OSI (h)	5.48 ± 0.05	5.65 ± 0.08	4.62 ± 0.05	18.0 ± 0.9	14.9 ± 0.4	14.9 ± 0.7

PV, peroxide value; OSI, oxidative stability index determined in the Rancimat test at 110 °C. Results represent the mean and the standard deviation of 3 analytical determinations (n=3).

Table S4 Quality parameters of the oil blends.

	OPO25-1	OPO25-2	OPO25-3	OPO50-1	OPO50-2	OPO50-3
Acidity (%)	0.09 ± 0.000	0.09 ± 0.000	0.07 ± 0.000	0.10 ± 0.000	0.10 ± 0.000	0.08 ± 0.000
PV (meq/kg)	3.74 ± 0.03	3.05 ± 0.03	4.06 ± 0.03	3.69 ± 0.04	3.13 ± 0.02	6.26 ± 0.04
OSI (h)	6.67 ± 0.09	6.98 ± 0.13	6.04 ± 0.10	8.87 ± 0.16	9.10 ± 0.09	7.95 ± 0.11

PV, peroxide value; OSI, oxidative stability index determined in the Rancimat test at 110 °C. Results represent the mean and the standard deviation of 3 analytical determinations (n=3).

Table S5 Influence of the beating process on the peroxide value (meq/kg fat).

Sample	Oil	Batter
SO-1	3.58 ± 0.06a	80 ± 2b
SO-2	3.29 ± 0.03a	94 ± 1b
SO-3	10.7 ± 0.1a	100 ± 2b
OPO25-1	3.74 ± 0.03a	85 ± 1b
OPO25-2	3.05 ± 0.03a	80 ± 1b
OPO25-3	4.06 ± 0.03a	81 ± 1b
OPO50-1	3.69 ± 0.04a	92 ± 7b
OPO50-2	3.13 ± 0.02a	81 ± 3b
OPO50-3	6.26 ± 0.04a	98 ± 1b
OPO-1	3.79 ± 0.03a	95 ± 1b
OPO-2	2.97 ± 0.04a	7.4 ± 0.1b
OPO-3	1.86 ± 0.05a	10.3 ± 0.3b

Results represent the mean value followed by the standard deviation of 3 analytical determinations. Different letters indicate significant differences according to Student's *t*-test ($p < 0.05$).

Table S6 Influence of the beating process on the levels of fat components (g/100 g fat) differing in molecular weight by direct HPSEC analysis in cupcakes prepared with sunflower oil (SO) or olive pomace oil (OPO).

Sample		TGD	DG*	MG	FFA
SO-1	Oil	0.55 ± 0.03a	1.70 ± 0.17a	0.12 ± 0.01a	0.28 ± 0.02a
	Batter	0.60 ± 0.03a	1.73 ± 0.02a	0.22 ± 0.02b	0.58 ± 0.01b
SO-2	Oil	0.53 ± 0.03a	1.66 ± 0.17a	0.12 ± 0.01a	0.28 ± 0.02a
	Batter	0.56 ± 0.01a	1.45 ± 0.15a	0.22 ± 0.02b	0.45 ± 0.01b
SO-3	Oil	0.99 ± 0.05b	1.54 ± 0.16a	0.14 ± 0.01a	0.34 ± 0.02a
	Batter	0.91 ± 0.01a	1.48 ± 0.03a	0.17 ± 0.01b	0.45 ± 0.01b
OPO-1	Oil	0.94 ± 0.05a	6.92 ± 0.71a	0.51 ± 0.05a	0.47 ± 0.03a
	Batter	1.05 ± 0.032a	6.42 ± 0.15a	0.66 ± 0.02b	0.95 ± 0.05b
OPO-2	Oil	0.85 ± 0.04a	7.17 ± 0.73a	0.57 ± 0.06a	0.57 ± 0.03a
	Batter	0.91 ± 0.03a	6.96 ± 0.01a	0.71 ± 0.02b	0.86 ± 0.03b
OPO-3	Oil	1.10 ± 0.06a	7.79 ± 0.79a	0.65 ± 0.06a	0.66 ± 0.04a
	Batter	1.01 ± 0.01a	7.53 ± 0.10a	0.68 ± 0.01a	0.80 ± 0.01b

*Chromatographic peak partially resolved. TGD, triglyceride dimers; DG, diglycerides; MG, monoglycerides; FFA, free fatty acids and other oil minor components. Results represent the mean value followed by the standard deviation of 3 analytical determinations. Different letters for a given group of compounds indicate significant differences between oil and batter according to Student's *t*-test ($p < 0.05$).

Table S7 Influence of the baking process on the peroxide value (meq/kg fat).

Sample	Batter	Cupcake
SO-1	80 ± 2a	84 ± 4a
SO-2	94 ± 1a	113 ± 2b
SO-3	100 ± 2b	89 ± 2a
OPO25-1	85 ± 1a	88 ± 3a
OPO25-2	80 ± 1a	77 ± 3a
OPO25-3	81 ± 1a	78 ± 3a
OPO50-1	92 ± 7b	83 ± 1a
OPO50-2	81 ± 3a	81 ± 3a
OPO50-3	98 ± 1b	83 ± 1a
OPO-1	95 ± 1b	80 ± 6a
OPO-2	7.4 ± 0.1a	39 ± 3b
OPO-3	10.3 ± 0.3a	77 ± 3b

Results represent the mean value followed by the standard deviation of 3 analytical determinations in an only oil extract (Batter) or in oil extracts of 3 independent samples (Cupcake). Different letters in a row indicate significant differences according to Student's *t*-test ($p < 0.05$).

Table S8 Changes in the content of squalene (mg/kg fat extract) and phytosterols (mg/kg fat extract) at the end of the shelf life (6 months).

Sample	Squalene		Total Phytosterols	
	Initial	Final	Initial	Final
Girasol 1	76 ± 11a	72 ± 1a	2346 ± 80a	2489 ± 116a
Orujo 25-1	359 ± 12b	400 ± 48a	2628 ± 155a	2991 ± 225a
Orujo 50-1	621 ± 8a	657 ± 32a	2370 ± 154a	2406 ± 84a
Orujo 1	1286 ± 52a	1337 ± 41a	2448 ± 121a	2491 ± 122a

Results represent the mean value followed by the standard deviation of 3 independent samples. Different letters indicate significant differences between the initial and final contents according to Student's *t*-test ($p < 0.05$).

Table S9 Changes in the content of triterpenic compounds (mg/kg fat extract) in OPO-1 at the end of the shelf-life (6 months).

	Initial	Final
Triterpenic alcohols	610 ± 21a	597 ± 16a
Erythrodiol	532 ± 17a	527 ± 24a
Uvaol	78 ± 6a	70 ± 8a
Triterpenic acids	66 ± 9a	71 ± 11a
Oleanolic	54 ± 6a	58 ± 8a
Ursolic	12 ± 3a	13 ± 4a
Maslinic	nd	nd

nd, not detected. Results represent the mean value followed by the standard deviation of 3 independent samples. Different letters indicate significant differences between the initial and final contents according to Student's *t*-test ($p < 0.05$).

Table S10 Consumer panel results for different attributes of cupcakes stored for 3 months.

Attributes	Samples				ANOVA / <i>p</i> -value
	SO-1	OPO25-1	OPO50-1	OPO-1	
Global appraisal	5.8 ± 1.9a	5.7 ± 1.9a	6.1 ± 1.6a	6.1 ± 1.7a	0.373
Appearance	6.4 ± 1.8a	6.2 ± 1.8a	6.2 ± 1.6a	6.3 ± 1.7a	0.971
Fresh appearance	5.5 ± 1.8a	5.4 ± 1.8a	5.6 ± 1.6a	5.6 ± 1.8a	0.953
Colour	6.5 ± 1.5a	6.4 ± 1.7a	6.6 ± 1.5a	6.6 ± 1.7a	0.885
Aroma	5.7 ± 1.8a	5.9 ± 1.8a	6.0 ± 1.7a	6.1 ± 1.9a	0.613
Flavour	5.5 ± 1.9a	5.7 ± 2.0a	6.2 ± 1.7a	6.2 ± 1.7a	0.110
Taste Intensity*	2.9 ± 0.9a	2.8 ± 0.8a	2.8 ± 0.8a	2.9 ± 0.7a	0.743
Sweet Taste*	2.9 ± 0.8a	2.8 ± 0.7a	3.0 ± 0.7a	3.0 ± 0.8a	0.373
Texture	4.5 ± 2.1a	4.4 ± 2.0a	4.8 ± 1.9a	4.7 ± 2.0a	0.651
Sponginess	3.8 ± 1.9a	3.7 ± 2.3a	4.3 ± 2.0a	4.0 ± 2.2a	0.386
Hard-soft texture	3.9 ± 1.7a	4.0 ± 1.9a	4.1 ± 1.8a	4.1 ± 1.9a	0.900
Dry-juicy texture	3.7 ± 1.8a	3.8 ± 2.0a	4.0 ± 1.9a	3.9 ± 2.0a	0.867
Freshness in mouth	4.4 ± 2.0a	4.2 ± 2.1a	4.5 ± 1.8a	4.6 ± 2.0a	0.724

Results represent the mean value followed by the standard deviation of 61 assessments (n=61). The attributes were assessed using a structured 9-level hedonic scale in which level 1 stands for “I do not like it at all” and level 9 “I like it very much”. Those attributes marked with an asterisk were assessed on a structured 5-level hedonic scale in which level 1 stands for “much milder than I would like” or “much less sweet than I would like”, level 2 for “a little milder or a little less sweet than I would like”, level 3 for “just as I like”, level 4 for “a little more intense or a little sweeter than I would like” and level 5 for “much more intense or much sweeter than I would like”. Different letters indicate significant differences between samples according to Duncan’s test ($p < 0.05$).

Table S11 Consumer panel results for different attributes of cupcakes stored for 6 months.

Attributes	Samples				ANOVA / <i>p</i> -value
	SO-1	OPO25-1	OPO50-1	OPO-1	
Global appraisal	5.7 ± 1.8a	5.9 ± 1.8a	5.6 ± 2.0a	5.9 ± 2.0a	0.811
Appearance	6.4 ± 1.7a	6.5 ± 1.9a	6.1 ± 2.0a	6.5 ± 1.8a	0.618
Fresh appearance	5.6 ± 2.0a	5.6 ± 2.1a	5.4 ± 2.2a	5.6 ± 2.1a	0.879
Colour	6.7 ± 1.8a	6.6 ± 1.9a	6.4 ± 2.0a	6.7 ± 1.8a	0.730
Aroma	5.7 ± 1.9a	5.7 ± 2.0a	5.2 ± 1.9a	5.9 ± 1.8a	0.275
Flavour	5.8 ± 1.9a	6.0 ± 2.1a	5.5 ± 2.2a	5.9 ± 1.9a	0.606
Taste Intensity*	2.8 ± 0.8a	2.7 ± 0.7a	2.9 ± 0.8a	2.8 ± 0.9a	0.691
Sweet Taste*	2.9 ± 0.8a	3.0 ± 0.7a	2.9 ± 0.8a	2.9 ± 0.8a	0.950
Texture	4.4 ± 2.0a	4.5 ± 2.0a	4.2 ± 2.1a	4.4 ± 2.1a	0.929
Sponginess	3.6 ± 2.0a	4.0 ± 2.1a	3.7 ± 2.1a	3.8 ± 2.0a	0.747
Hard-soft texture	3.9 ± 1.9a	4.0 ± 2.1a	3.5 ± 2.0a	4.0 ± 2.0a	0.547
Dry-juicy texture	3.7 ± 1.9a	3.9 ± 2.1a	3.4 ± 2.2a	3.9 ± 2.0a	0.641
Freshness in mouth	4.3 ± 2.1a	4.4 ± 2.2a	4.0 ± 2.3a	4.2 ± 2.0a	0.658

Results represent the mean value followed by the standard deviation of 61 assessments (n=61). The attributes were assessed using a structured 9-level hedonic scale in which level 1 stands for “I do not like it at all” and level 9 “I like it very much”. Those attributes marked with an asterisk were assessed on a structured 5-level hedonic scale in which level 1 stands for “much milder than I would like” or “much less sweet than I would like”, level 2 for “a little milder or a little less sweet than I would like”, level 3 for “just as I like”, level 4 for “a little more intense or a little sweeter than I would like” and level 5 for “much more intense or much sweeter than I would like”. Different letters indicate significant differences between samples according to Duncan’s test ($p < 0.05$).

Table S12 Consumer panel results for different attributes of cupcakes containing SO-1 over storage.

Attributes	Samples			ANOVA / <i>p</i> -value
	0-M	3-M	6-M	
Global appraisal	6.5 ± 1.5a	5.8 ± 1.9b	5.7 ± 1.8b	0.027
Appearance	6.9 ± 1.4a	6.4 ± 1.8a	6.4 ± 1.7a	0.137
Fresh appearance	6.6 ± 1.6a	5.5 ± 1.8b	5.6 ± 2.0b	< 0.001
Colour	6.7 ± 1.6a	6.5 ± 1.5a	6.7 ± 1.8a	0.684
Aroma	6.7 ± 1.7a	5.7 ± 1.8b	5.7 ± 1.9b	0.002
Flavour	6.3 ± 1.6a	5.5 ± 1.9b	5.8 ± 1.9ab	0.043
Taste Intensity*	2.7 ± 0.7a	2.9 ± 0.9a	2.8 ± 0.8a	0.341
Sweet Taste*	2.9 ± 0.7a	2.9 ± 0.8a	2.9 ± 0.8a	0.897
Texture	5.8 ± 1.6a	4.5 ± 2.1b	4.4 ± 2.0b	< 0.001
Sponginess	5.5 ± 1.9a	3.8 ± 1.9b	3.6 ± 2.0b	< 0.001
Hard-soft texture	5.3 ± 1.6a	3.9 ± 1.7b	3.9 ± 1.9b	< 0.001
Dry-juicy texture	5.1 ± 1.6a	3.7 ± 1.8b	3.7 ± 1.9b	< 0.001
Freshness in mouth	5.7 ± 1.8a	4.4 ± 2.0b	4.3 ± 2.1b	< 0.001

Results represent the mean value followed by the standard deviation of 61 assessments (n=61). The attributes were assessed using a structured 9-level hedonic scale in which level 1 stands for “I do not like it at all” and level 9 “I like it very much”. Those attributes marked with an asterisk were assessed on a structured 5-level hedonic scale in which level 1 stands for “much milder than I would like” or “much less sweet than I would like”, level 2 for “a little milder or a little less sweet than I would like”, level 3 for “just as I like”, level 4 for “a little more intense or a little sweeter than I would like” and level 5 for “much more intense or much sweeter than I would like”. Different letters indicate significant differences between samples according to Duncan’s test ($p < 0.05$).

Table S13 Consumer panel results for different attributes of cupcakes containing OPO25-1 over storage.

Attributes	Samples			ANOVA / <i>p</i> -value
	0-M	3-M	6-M	
Global appraisal	6.7 ± 1.3a	5.7 ± 1.9b	5.9 ± 1.8b	0.002
Appearance	7.0 ± 1.3a	6.2 ± 1.8b	6.5 ± 1.9ab	0.067
Fresh appearance	6.7 ± 1.3a	5.4 ± 1.8b	5.6 ± 2.1b	< 0.001
Colour	6.9 ± 1.5a	6.4 ± 1.7a	6.6 ± 1.9a	0.281
Aroma	6.7 ± 1.5a	5.9 ± 1.8b	5.7 ± 2.0b	0.005
Flavour	6.9 ± 1.3a	5.7 ± 2.0b	6.0 ± 2.1b	0.002
Taste Intensity*	2.8 ± 0.7a	2.8 ± 0.8a	2.7 ± 0.7a	0.916
Sweet Taste*	3.0 ± 0.6a	2.8 ± 0.7a	3.0 ± 0.7a	0.254
Texture	6.0 ± 1.6a	4.4 ± 2.0b	4.5 ± 2.0b	< 0.001
Sponginess	5.8 ± 1.6a	3.7 ± 2.3b	4.0 ± 2.1b	< 0.001
Hard-soft texture	5.7 ± 1.5a	4.0 ± 1.9b	4.0 ± 2.1b	< 0.001
Dry-juicy texture	5.6 ± 1.7a	3.8 ± 2.0b	3.9 ± 2.1b	< 0.001
Freshness in mouth	5.9 ± 1.4a	4.2 ± 2.1b	4.4 ± 2.2b	< 0.001

Results represent the mean value followed by the standard deviation of 61 assessments (n=61). The attributes were assessed using a structured 9-level hedonic scale in which level 1 stands for “I do not like it at all” and level 9 “I like it very much”. Those attributes marked with an asterisk were assessed on a structured 5-level hedonic scale in which level 1 stands for “much milder than I would like” or “much less sweet than I would like”, level 2 for “a little milder or a little less sweet than I would like”, level 3 for “just as I like”, level 4 for “a little more intense or a little sweeter than I would like” and level 5 for “much more intense or much sweeter than I would like”. Different letters indicate significant differences between samples according to Duncan’s test ($p < 0.05$).

Table S14 Consumer panel results for different attributes of cupcakes containing OPO50-1 over storage.

Attributes	Samples			ANOVA / <i>p</i> -value
	0-M	3-M	6-M	
Global appraisal	6.5 ± 1.3a	6.1 ± 1.6ab	5.6 ± 2.0b	0.012
Appearance	6.9 ± 1.5a	6.2 ± 1.6b	6.1 ± 2.0b	0.030
Fresh appearance	6.7 ± 1.3a	5.6 ± 1.6b	5.4 ± 2.2b	< 0.001
Colour	7.0 ± 1.4a	6.6 ± 1.5ab	6.4 ± 2.0b	0.106
Aroma	6.7 ± 1.7a	6.0 ± 1.7b	5.2 ± 1.9c	< 0.001
Flavour	6.8 ± 1.4a	6.2 ± 1.7a	5.5 ± 2.2b	< 0.001
Taste Intensity*	2.7 ± 0.7a	2.8 ± 0.8a	2.9 ± 0.8a	0.286
Sweet Taste*	3.0 ± 0.6a	3.0 ± 0.7a	2.9 ± 0.8a	0.561
Texture	5.8 ± 1.5a	4.8 ± 1.9b	4.2 ± 2.1b	< 0.001
Sponginess	5.4 ± 1.7a	4.3 ± 2.0b	3.7 ± 2.1b	< 0.001
Hard-soft texture	5.5 ± 1.4a	4.1 ± 1.8b	3.5 ± 2.0b	< 0.001
Dry-juicy texture	5.2 ± 1.5a	4.0 ± 1.9b	3.4 ± 2.2b	< 0.001
Freshness in mouth	5.9 ± 1.4a	4.5 ± 1.8b	4.0 ± 2.3b	< 0.001

Results represent the mean value followed by the standard deviation of 61 assessments (n=61). The attributes were assessed using a structured 9-level hedonic scale in which level 1 stands for “I do not like it at all” and level 9 “I like it very much”. Those attributes marked with an asterisk were assessed on a structured 5-level hedonic scale in which level 1 stands for “much milder than I would like” or “much less sweet than I would like”, level 2 for “a little milder or a little less sweet than I would like”, level 3 for “just as I like”, level 4 for “a little more intense or a little sweeter than I would like” and level 5 for “much more intense or much sweeter than I would like”. Different letters indicate significant differences between samples according to Duncan’s test ($p < 0.05$).

Table S15 Consumer panel results for different attributes of cupcakes containing OPO-1 over storage.

Attributes	Samples			ANOVA / <i>p</i> -value
	0-M	3-M	6-M	
Global appraisal	6.6 ± 1.4a	6.1 ± 1.7ab	5.9 ± 2.0b	0.052
Appearance	6.7 ± 1.4a	6.3 ± 1.7a	6.5 ± 1.8a	0.391
Fresh appearance	6.7 ± 1.3a	5.6 ± 1.8b	5.6 ± 2.1b	< 0.001
Colour	7.0 ± 1.4a	6.6 ± 1.7a	6.7 ± 1.8a	0.393
Aroma	7.0 ± 1.4a	6.1 ± 1.9b	5.9 ± 1.8b	0.002
Flavour	6.8 ± 1.2a	6.2 ± 1.7b	5.9 ± 1.9b	0.011
Taste Intensity*	2.9 ± 0.7a	2.9 ± 0.7a	2.8 ± 0.9a	0.560
Sweet Taste*	3.1 ± 0.7a	3.0 ± 0.8a	2.9 ± 0.8a	0.318
Texture	6.0 ± 1.7a	4.7 ± 2.0b	4.4 ± 2.1b	< 0.001
Sponginess	5.8 ± 2.0a	4.0 ± 2.2b	3.8 ± 2.0b	< 0.001
Hard-soft texture	6.0 ± 1.6a	4.1 ± 1.9b	4.0 ± 2.0b	< 0.001
Dry-juicy texture	5.5 ± 1.8a	3.9 ± 2.0b	3.9 ± 2.0b	< 0.001
Freshness in mouth	6.0 ± 1.6a	4.6 ± 2.0b	4.2 ± 2.0b	< 0.001

Results represent the mean value followed by the standard deviation of 61 assessments (n=61). The attributes were assessed using a structured 9-level hedonic scale in which level 1 stands for “I do not like it at all” and level 9 “I like it very much”. Those attributes marked with an asterisk were assessed on a structured 5-level hedonic scale in which level 1 stands for “much milder than I would like” or “much less sweet than I would like”, level 2 for “a little milder or a little less sweet than I would like”, level 3 for “just as I like”, level 4 for “a little more intense or a little sweeter than I would like” and level 5 for “much more intense or much sweeter than I would like”. Different letters indicate significant differences between samples according to Duncan’s test ($p < 0.05$).