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The Potential of Olive Leaf Extract as a Functional Ingredient in Yogurts: Physicochemical, Texture, and Antioxidant Effects

Ines Tarchi[1,3], Mohamed Bouaziz[1,2] and Abderrahmane Aït-Kaddour[3,4]

[1] Laboratory of Electrochemistry and Environment, National School of Engineers of Sfax (ENIS), University of Sfax, BP 1175, 3038 Sfax, Tunisia

[2] Institut supérieur de Biotechnologie de Sfax, Université de Sfax, BP1175, 3038 Sfax, Tunisia

[3] Université Clermont-Auvergne, INRAE, VetAgro Sup, Unité Mixte de Recherche sur le Fromage UMRF, 89 Avenue de l'Europe, France

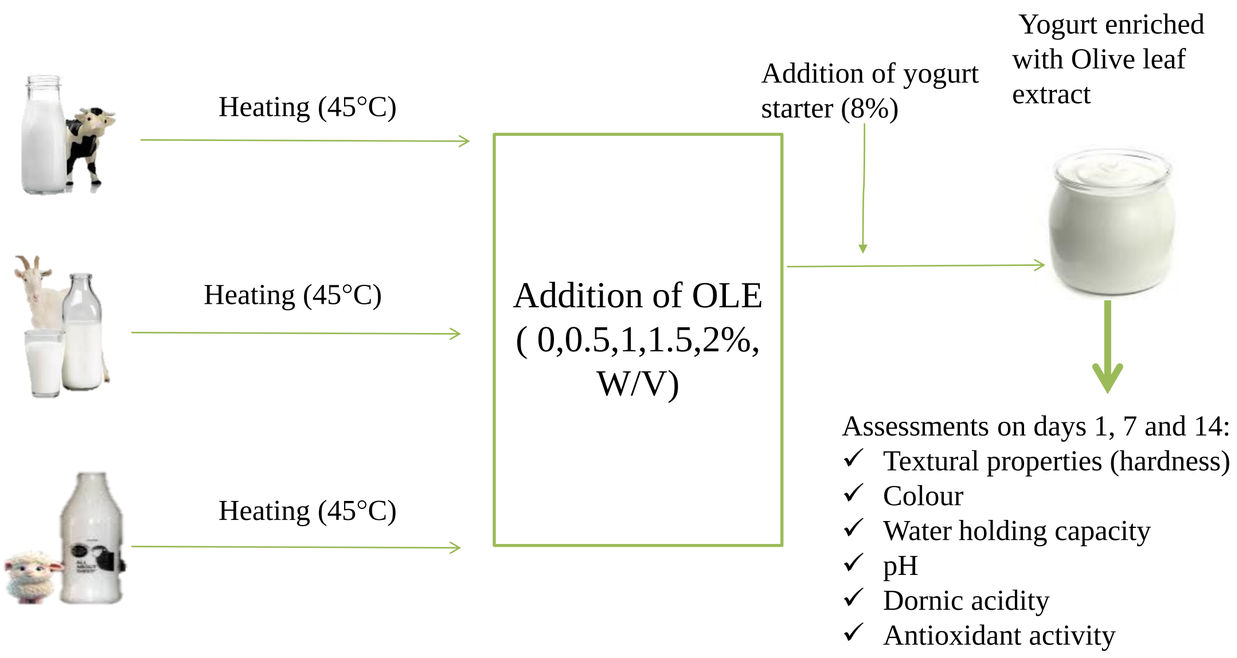
[4] Departement of Food Technology, Faculty of Agroindustrial Technology, University of Padjadjaran, Sumedang 45363, Jawa Barat, Indonesia

INTRODUCTION & AIM

Yogurt, known for its nutritional value and flavor variety, can be made from cow, sheep, or goat's milk, each offering unique sensory and nutritional benefits. Increasingly, natural ingredients like olive leaf extract (OLE), rich in polyphenols such as oleuropein, are being studied for their ability to enhance yogurt's health benefits. OLE, known for its antioxidant, anti-inflammatory, and antimicrobial properties, can enrich yogurt's nutritional profile, extend shelf life, and improve quality.

Most research has focused on cow's milk yogurt, but this study compares the impact of OLE on yogurt made from cow, sheep, and goat's milk to explore its potential across different milk types.

METHOD



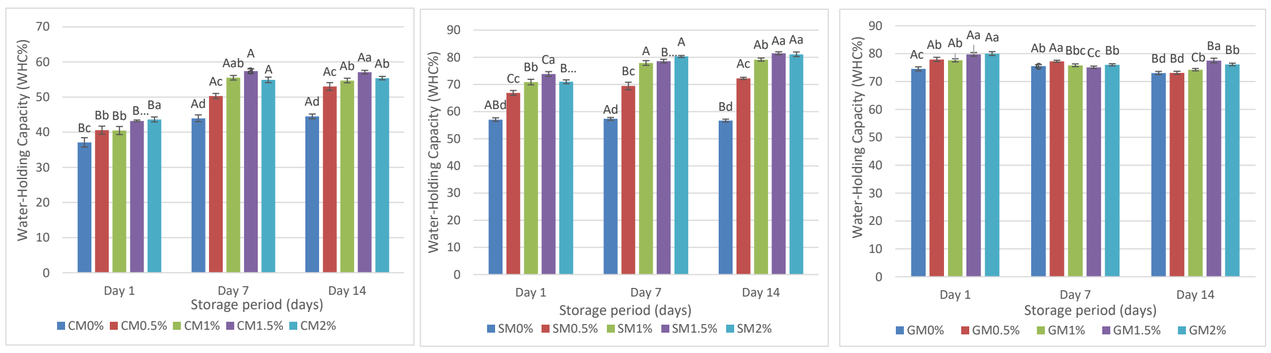
RESULTS & DISCUSSION

Table 1: Total phenolic compound and Antioxidant activity of yogurt

Yogurt type		Storage period (days)	0%	0.5%	1%	1.5%	2%
Cow milk	TPC mg GAE/100g	1	$34.69^{Ae} \pm 1.78$	$139.01^{ABd} \pm 2.43$	$248.74^{Ac} \pm 4.87$	$373.97^{Ab} \pm 1.62$	$465.31^{Aa} \pm 21.91$
		7	$26.76^{Be} \pm 0.64$	$120.06^{Bd} \pm 0$	$196.65^{Bc} \pm 5.18$	$328.39^{Bb} \pm 1.75$	$357.31^{Ba} \pm 6.49$
		14	$28.76^{Be} \pm 0.35$	$146.86^{Ad} \pm 7.82$	$271.71^{Ac} \pm 10.95$	$385.84^{Ab} \pm 10.61$	$494.79^{Aa} \pm 2.59$
Sheep milk		1	$33.20^{Be} \pm 1$	$133.27^{Bd} \pm 0.81$	$207.37^{Bc} \pm 3.97$	$305.03^{Bb} \pm 1.98$	$468.37^{Aa} \pm 8.06$
		7	$37.26^{Ae} \pm 1.30$	$164.99^{Ad} \pm 3.85$	$247.01^{Ac} \pm 5.68$	$338.73^{Ab} \pm 1.32$	$360.75^{Ba} \pm 11.37$
		14	$37.56^{Ae} \pm 0.91$	$130.27^{Bd} \pm 2.30$	$179.42^{Cc} \pm 2.65$	$274.01^{Cb} \pm 3.24$	$384.88^{Ba} \pm 3.24$
Goat milk		1	$25.62^{Be} \pm 1.21$	$153.95^{Bd} \pm 2.43$	$296.42^{Ac} \pm 2.43$	$427.58^{Ab} \pm 7.47$	$460.71^{Ca} \pm 0$
		7	$29.52^{Ae} \pm 0.60$	$169.59^{Ad} \pm 3.63$	$285.50^{Bc} \pm 1.62$	$422.51^{Ab} \pm 5.25$	$497.48^{Ba} \pm 6.49$
		14	$32.97^{Ae} \pm 2.10$	$149.16^{Bd} \pm 6.92$	$287.22^{Bc} \pm 0.81$	$399.82^{Bb} \pm 4.06$	$572.16^{Aa} \pm 1.62$
Cow milk	DPPH µmol TE/100 g	1	$14.90^{Ad} \pm 3.29$	$30.21^{Cc} \pm 0.84$	$44.11^{Bab} \pm 2$	$47.90^{Ba} \pm 0.51$	$38.62^{Bb} \pm 0.45$
		7	$15.89^{Ad} \pm 0.66$	$42.44^{Ac} \pm 0.42$	$52.31^{Aa} \pm 0.09$	$52.41^{Aa} \pm 0.06$	$48.63^{Ab} \pm 1.03$
		14	$23.16^{Ae} \pm 1.34$	$37.43^{Bd} \pm 0.36$	$42.57^{Bc} \pm 0.15$	$46.45^{Cb} \pm 0.26$	$31.33^{Ca} \pm 0.89$
Sheep milk		1	$24.47^{Ac} \pm 0.88$	$33.37^{Ab} \pm 0.49$	$34.96^{Bb} \pm 0.21$	$38.79^{Ba} \pm 1.25$	$33.47^{Ab} \pm 0.99$
		7	$11.46^{Bc} \pm 0.35$	$29.74^{Ab} \pm 1.87$	$37.47^{Aa} \pm 0.49$	$36.50^{Ba} \pm 0.54$	$32.27^{Ab} \pm 1.25$
		14	$8.93^{Cd} \pm 0.36$	$32.91^{Ac} \pm 0.05$	$34.40^{Bbc} \pm 0.28$	$42.61^{Aa} \pm 0.05$	$34.52^{Ab} \pm 0.76$
Goat milk		1	$6.08^{Aa} \pm 0.68$	$31.52^{Bb} \pm 0.06$	$31.21^{Bb} \pm 0.31$	$27.52^{Bc} \pm 0.50$	$28.57^{Cc} \pm 0.66$
		7	$5.93^{Ad} \pm 0.69$	$46.34^{Aa} \pm 0.73$	$35.07^{Ab} \pm 0.61$	$32.25^{Ac} \pm 0.65$	$33.49^{Bbc} \pm 0.36$
		14	$7.80^{Ae} \pm 0.88$	$45.82^{Aa} \pm 1.15$	$34.55^{Ac} \pm 1.07$	$24.94^{Bd} \pm 1.43$	$40.64^{Ab} \pm 0.05$

- ✓ The addition of OLE (olive leaf extract) to yogurt effectively increased its antioxidant capacity.
- ✓ Yogurt supplemented with OLE showed higher total phenol content and antioxidant activity.

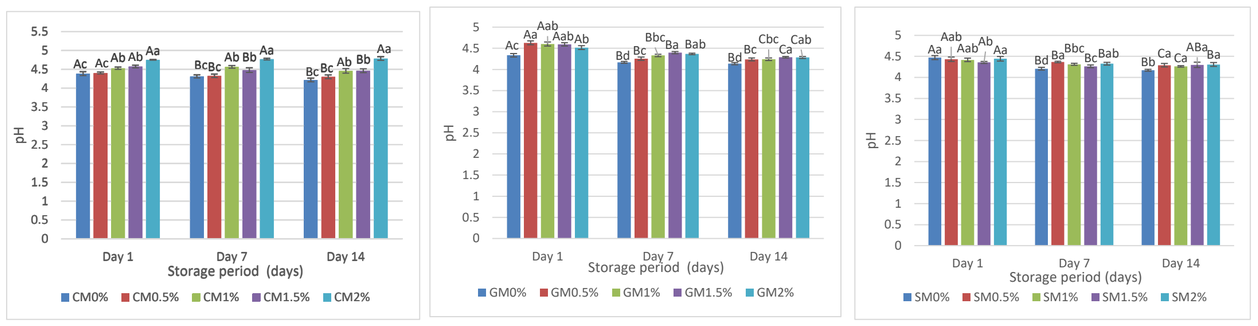
Figure 1: Water holding capacity (WHC) of yogurt enriched with Olive leaf extract powder (0%, 0.5%, 1%, 1.5% and 2%, W/V) during cold storage samples. CM: cow milk, SM: sheep milk; GM: goat milk



- ✓ Higher OLE concentrations increased WHC, likely due to higher solids content and polyphenol-protein interactions.
- ✓ WHC slightly increased for cow's and sheep's milk yogurts but decreased for goat's milk.
- ✓ WHC differences are due to milk composition.

RESULTS & DISCUSSION

Figure 2: pH of yogurts enriched with olive leaf extract powder (0%, 0.5%, 1%, 1.5% and 2%, W/V) during cold storage. CM: cow milk, SM: sheep milk; GM: goat milk.



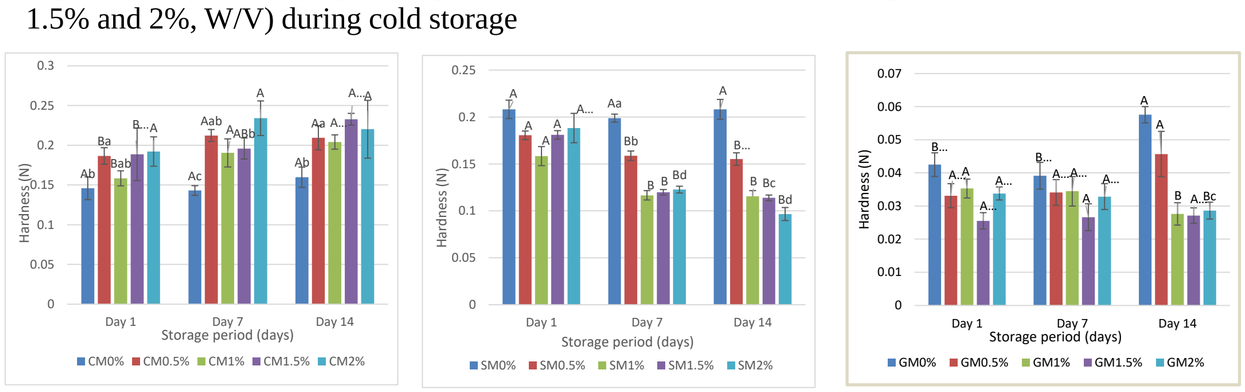
- ✓ Adding OLE did not significantly affect pH.
- ✓ pH decreased during cold storage due to lactose conversion to organic acids.
- ✓ Goat's milk yogurt had a slightly lower pH than cow and sheep's milk yogurts.

Table 2: Colour of yogurt samples enriched with Olive leaf extract powder (0%, 0.5%, 1%, 1.5% and 2%, W/V) during cold storage

Yogurt type	Factors	Storage period (days)	0%	0.5%	1%	1.5%	2%
Cow milk	L	1	$88.17^{Aa} \pm 0.22$	$86.40^{Bb} \pm 0.07$	$84.34^{Ac} \pm 0.45$	$82.76^{Ad} \pm 0.05$	$80.35^{Ae} \pm 0.20$
		7	$88.10^{Aa} \pm 0.78$	$86.45^{ABb} \pm 0.21$	$84.32^{Ac} \pm 0.15$	$82.34^{Cd} \pm 0.15$	$80.08^{Be} \pm 0.06$
		14	$87.91^{Aa} \pm 0.09$	$86.67^{Aa} \pm 0.14$	$84.17^{Ab} \pm 0.15$	$82.55^{Bc} \pm 0.07$	$80.27^{ABd} \pm 0.06$
Sheep milk		1	$86.81^{Aa} \pm 0.64$	$86.67^{ABa} \pm 0.16$	$85.20^{Ab} \pm 0.15$	$83.91^{Ac} \pm 0.06$	$82.15^{Ad} \pm 0.08$
		7	$86.53^{Aa} \pm 0.39$	$86.83^{Aa} \pm 0.21$	$84.62^{Bb} \pm 0.11$	$83.24^{Bc} \pm 0.18$	$81.69^{Bd} \pm 0.13$
		14	$87.28^{Aa} \pm 1.26$	$86.44^{Ba} \pm 0.34$	$84.81^{Bb} \pm 0.12$	$83.02^{Bc} \pm 0.21$	$81.51^{Bd} \pm 0.17$
Goat milk		1	$88.22^{Ba} \pm 0.47$	$86.82^{Ab} \pm 0.11$	$84.92^{Ac} \pm 0.46$	$83.38^{Ad} \pm 0.19$	$81.31^{Ae} \pm 0.19$
		7	$88.00^{Ba} \pm 0.4$	$85.26^{Bb} \pm 0.68$	$84.25^{Bc} \pm 0.21$	$83.16^{Bd} \pm 0.11$	$81.32^{Ae} \pm 0.21$
		14	$89.55^{Aa} \pm 0.80$	$87.15^{Ab} \pm 0.23$	$84.72^{ABc} \pm 0.26$	$83.31^{ABd} \pm 0.07$	$81.47^{Ae} \pm 0.07$
Cow milk	a	1	$-2.83^{Ae} \pm 0.05$	$-2.34^{Bd} \pm 0.05$	$-1.10^{Ac} \pm 0.41$	$-0.24^{Ab} \pm 0.03$	$0.41^{Ba} \pm 0.02$
		7	$-2.81^{Ae} \pm 0.16$	$-2.22^{Bd} \pm 0.05$	$-1.08^{Ac} \pm 0.06$	$-0.83^{Bb} \pm 0.15$	$-0.06^{Ca} \pm 0.06$
		14	$-2.8^{Ae} \pm 0.05$	$-2.06^{Ad} \pm 0.16$	$-1.16^{Ac} \pm 0.22$	$-0.15^{Ab} \pm 0.14$	$0.72^{Aa} \pm 0.03$
Sheep milk		1	$-2.90^{Ae} \pm 0.15$	$-2.45^{Bd} \pm 0.07$	$-1.47^{Ac} \pm 0.10$	$-0.36^{Ab} \pm 0.08$	$0.086^{Aa} \pm 0.09$
		7	$-2.97^{ABe} \pm 0.05$	$-2.08^{Ad} \pm 0.12$	$-1.54^{Ac} \pm 0.09$	$-0.69^{Bb} \pm 0.17$	$0.20^{Aa} \pm 0.09$
		14	$-3.17^{Be} \pm 0.23$	$-2.41^{Bd} \pm 0.13$	$-1.4^{Ac} \pm 0.22$	$-0.8^{Bb} \pm 0.27$	$0.20^{Aa} \pm 0.13$
Goat milk		1	$-2.19^{Ac} \pm 0.06$	$-2.11^{Bc} \pm 0.06$	$-1.46^{Ab} \pm 0.36$	$-0.97^{Ba} \pm 0.22$	$-0.69^{Ca} \pm 0.23$
		7	$-2.19^{Ad} \pm 0.07$	$-2.37^{Cd} \pm 0.08$	$-1.82^{Ac} \pm 0.12$	$-0.84^{ABb} \pm 0.10$	$-0.36^{Ba} \pm 0.24$
		14	$-2.49^{Be} \pm 0.11$	$-1.86^{Ad} \pm 0.13$	$-1.44^{Ac} \pm 0.24$	$-0.62^{Ab} \pm 0.09$	$0.34^{Aa} \pm 0.01$
Cow milk	b	1	$5.32^{Ae} \pm 0.25$	$11.57^{Bd} \pm 0.10$	$14.94^{Ac} \pm 0.43$	$17.06^{Ab} \pm 0.05$	$18.45^{Aa} \pm 0.05$
		7	$5.24^{Ae} \pm 0.97$	$11.81A^{Bd} \pm 0.07$	$14.96^{Ac} \pm 0.08$	$16.45^{Cb} \pm 0.17$	$17.94^{Ba} \pm 0.08$
		14	$5.07^{Ae} \pm 0.33$	$11.94^{Ad} \pm 0.31$	$14.55^{Ac} \pm 0.35$	$16.79^{Bb} \pm 0.07$	$17.88^{Ba} \pm 0.04$
Sheep milk		1	$5.13^{Aa} \pm 0.69$	$10.94^{Bb} \pm 0.23$	$14.12^{Ac} \pm 0.23$	$16.32^{Ad} \pm 0.08$	$17.55^{Ae} \pm 0.12$
		7	$5.04^{Aa} \pm 0.45$	$11.89^{Ab} \pm 0.27$	$13.70^{Bc} \pm 0.13$	$15.73^{Bd} \pm 0.20$	$17.34^{Be} \pm 0.12$
		14	$6.27^{Aa} \pm 1.46$	$11.39^{ABb} \pm 0.50$	$14.09^{Ac} \pm 0.33$	$15.68^{Bd} \pm 0.22$	$17.25^{Be} \pm 0.04$
Goat milk		1	$2.59^{Be} \pm 0.45$	$9.59^{Bd} \pm 0.17$	$13.05^{Ac} \pm 0.68$	$15.21^{Ab} \pm 0.27$	$16.73^{Ba} \pm 0.38$
		7	$2.51^{Be} \pm 0.40$	$7.63^{Cd} \pm 0.90$	$12.21^{Bc} \pm 0.29$	$15.25^{Ab} \pm 0.18$	$16.93^{Ba} \pm 0.26$
		14	$4.34^{Ae} \pm 0.98$	$10.45^{Ad} \pm 0.27$	$13.11^{Ac} \pm 0.40$	$15.49^{Ab} \pm 0.07$	$17.49^{Aa} \pm 0.05$

- ✓ OLE caused a decrease in brightness (L*) as its concentration increased.
- ✓ OLE led to an increase in red tint (a*) with higher concentrations.
- ✓ OLE resulted in a more yellow appearance (b*) as its levels rised.

Figure 3: Hardness of yogurt samples enriched with Olive leaf extract powder (0%, 0.5%, 1%, 1.5% and 2%, W/V) during cold storage



- ✓ Hardness of cow's milk yogurt increased with storage time and OLE concentration.
- ✓ With OLE, firmness stayed stable until day 7, then decreased by day 14, for goat milk yogurt
- ✓ Sheep's milk yogurt showed a decrease in firmness with both storage time and OLE concentration

CONCLUSION

- The incorporation of OLE into yogurt enhanced its antioxidant activity and its phenolic composition
- OLE may be beneficial for enriching yogurts, but further research is needed to optimize its dosage and limit effects on sensory properties and preservation.