1st International Multidisciplinary Acorn as Food Workshop

ACORN 2024
17-18 DECEMBER, 2024

Exploring acorn flour as nutritional ingredient: From traditional food use to the compositional and antioxidant characterization of three oak species grown in Apulia

Department of Soil, Plant and Food Science, University of Bari Aldo Moro, Via Amendola, 165/a, 70126 Bari, Italy

Antonella Pasqualone*, Giacomo Squeo, Francesca Vurro, Carmine Summo*

ACORN2024

Traditional use of acorns in food

ACORN2024

Balanophagy

Archaeological and historical evidences show that in **antiquity** acorns were largely used as **food**

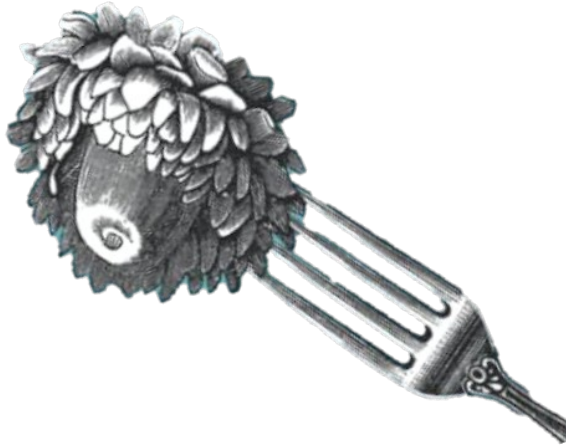
Acorn remains were found on **rotary querns** and in **cooking tools**, starting from the **3rd millennium BC**

De Re Coquinaria, a recipe book of the Roman gastronome **Apicius** (1st century AD) mentions the use of acorns in a recipe for stuffed hare

Pliny the Elder (23–79 AD), in his ***Naturalis Historiae*** mentioned that **roasting** acorns made them sweeter


C. PLINII SECUNDI
NATURALIS HISTORIÆ,
TOMUS PRIMUS.
Cum Commentariis & adnotationibus HERMOLAI BARBARI, PINTIANI, RHENANI, GELENII, DALECHAMPII, SCALIGERI, SALMASII, Is. VOSSII, & Variorum.
Accedunt præterea variæ Lectiones ex MSS. complurib. ad oram Paginarum accurate indicatæ.
Item JOH. FR. GRONOVII Notarum Liber Singularis ad Illustrem Virum Johannem Capelanum.
MOVENDO
LUGD. BATAV. ROTERODAMI. } Apud HACKIOS, A°. 1669.

βάλανος (balanos) = acorn; φαγία (phagía): to eat



ACORN2024

Balanophagy over time

Acorns have been a staple food in:

- Southern Italy and Sardinia (Pinna, 2013; Zocchi et al., 2022)
- Iberian peninsula (Rakić et al., 2006)
- Poland and Baltic countries (Łuczaj, 2011)
- Türkiye, Middle East, Central Asia (Silva et al., 2016; Zocchi et al., 2022)
- Central and North America (Bainbridge, 1987)

Food use of acorns was **common** until the **second World War**

Later, acorns came to be perceived as **food for the poor** or **animal feed**

12th century relief of pigs eating acorns in the Baptistery of Parma, Italy

From decadence to revival

Now there is a **revival, due to the rediscovery of phytochemicals**

Acorns are valued especially by vegan and vegetarian consumers, oriented toward **organic, sustainable** and **traditional** foods, also **gluten-free**

Revival

applied sciences

MDPI

Review

Acorns as a Source of Valuable Compounds for Food and Medical Applications: A Review of *Quercus* Species Diversity and Laboratory Studies

Emilia Szabłowska [1] and Małgorzata Tańska [2,*]

Appl. Sci. **2024**, *14*, 2799. https://doi.org/10.3390/app14072799 https://www.mdpi.com/journal/applsci

Comprehensive REVIEWS in Food Science and Food Safety

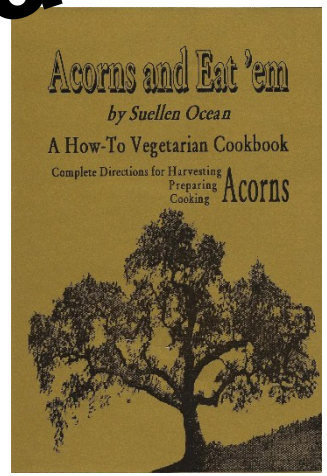
A New Age for *Quercus* spp. Fruits: Review on Nutritional and Phytochemical Composition and Related Biological Activities of Acorns

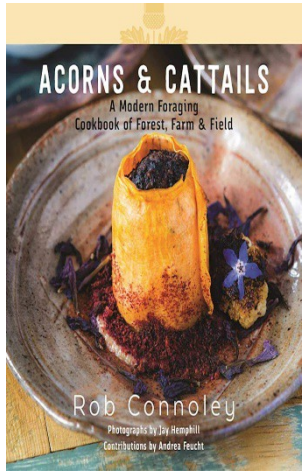
Ana F. Vinha, João C. M. Barreira, Anabela S.G. Costa, and M. Beatriz P. P. Oliveira

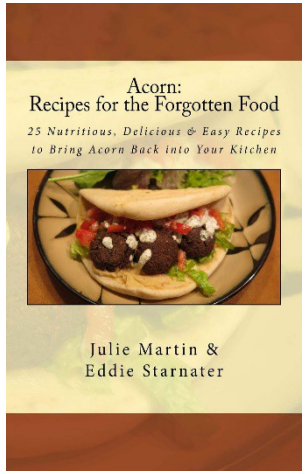
ACORN2024

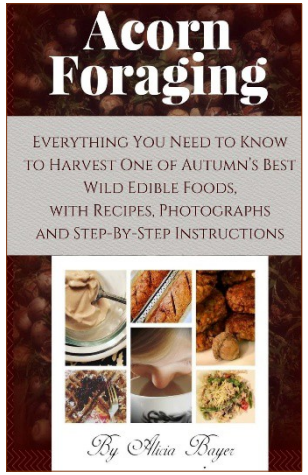
A rapidly growing interest

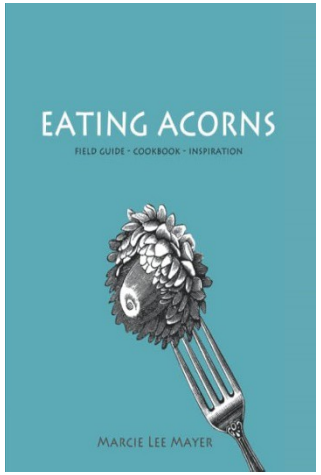
Books

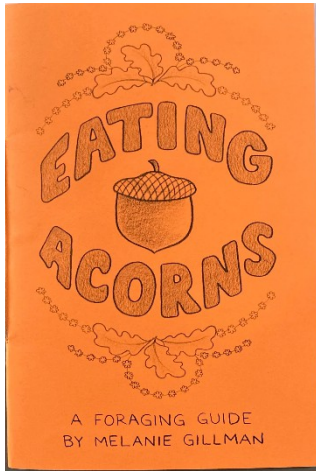




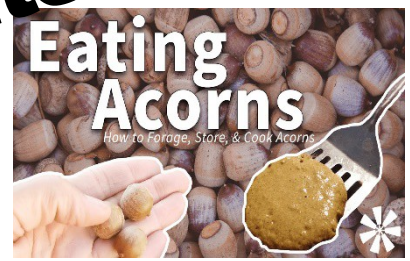






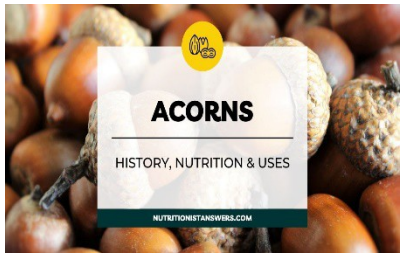


Websites



Eating Acorns

60+ Acorn Recipes

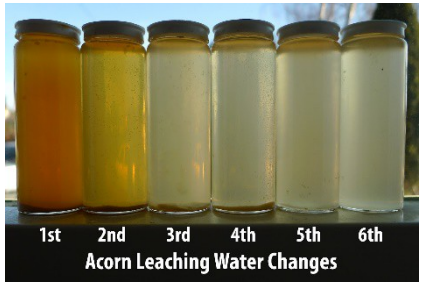


ACORN2024

Preparation of acorn flour

Acorn sorting (dumping into water)

Tannin reduction (water; heat; clay treatment)



Drying (oven or sun, 40 °C) or Roasting

Buttery and nutty
vs
Robust toasted flavor

Shelling and milling

ACORN2024

Traditional food use of acorns

Acorns were traditionally used to prepare **porridge**, **bread**, **cakes** and **coffee-like beverages**

In a previous study we focused on **acorn bread**

We recorded the ingredients and preparation techniques **still used today** or at least **present in the memory of elders**

Surveyed countries: Italy, Algeria, Afghanistan, Iraq, Iran and Syria

foods

Article

Food Security beyond Cereals: A Cross-Geographical Comparative Study on Acorn Bread Heritage in the Mediterranean and the Middle East

Dauro Mattia Zocchi [1,*], Camilla Bondioli [1], Seyed Hamzeh Hosseini [2], Mohamed Djamel Miara [3], Carmelo Maria Musarella [4], Datis Mohammadi [1], Ajmal Khan Manduzai [5], Kovan Dilawer Issa [6], Naji Sulaiman [7], Chadi Khatib [8], Hiwa M. Ahmed [9,10], Tola Abdulsattar Faraj [6,11], Hawraz Ibrahim M. Amin [12,13], Faiq H. S. Hussain [6], Abdullah Faiz [1,14], Antonella Pasqualone [15], Frits Heinrich [16,17], Michele Filippo Fontefrancesco [1,18] and Andrea Pieroni [1,6]

Foods **2022**, *11*, 3898. https://doi.org/10.3390/foods11233898 https://www.mdpi.com/journal/foods

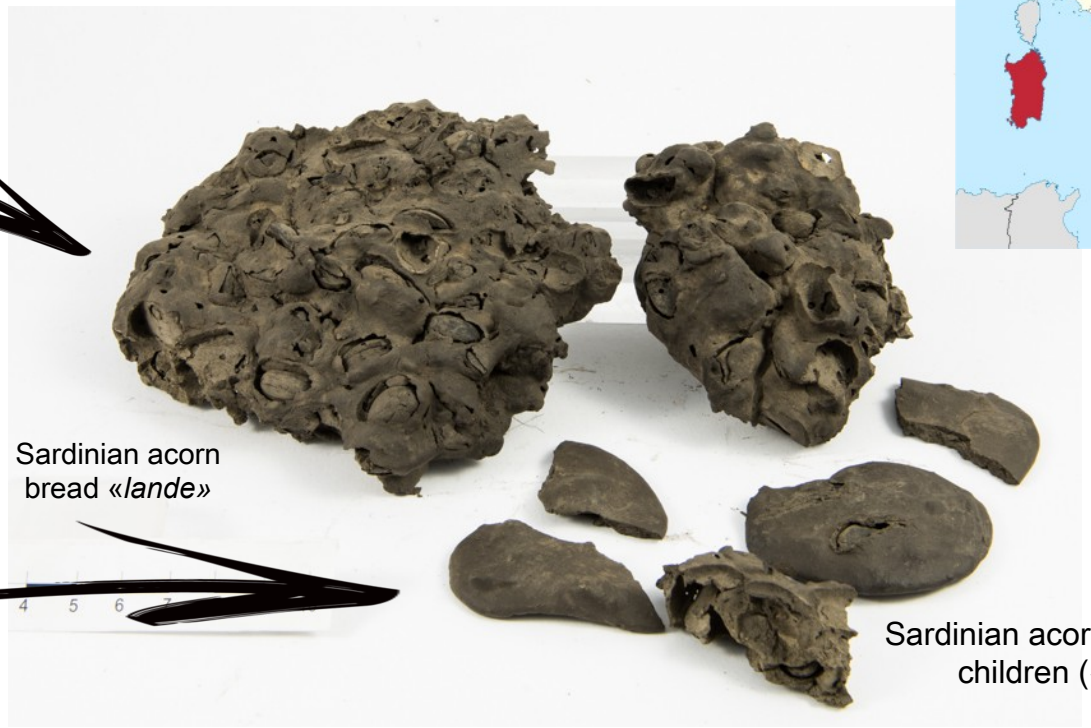
ACORN2024

Traditional preparation of acorn bread in Sardinia, (abandoned) Italy

Shelled acorns + clay + water, boiling (5 h); adding ash when almost done

Taking the solid part (entire acorns with some clay), shaping it as flat cakes (bread) and drying

Boiling the remaining semifluid suspension until creamy (acorn pieces and few clay), then shaping as biscuits and drying



Sardinian acorn bread «*lande*»

Sardinian acorn biscuits for children («*Fitta*»)

Geophagy!

ACORN2024

Traditional preparation of acorn bread in Iran

In Iran and Iraq acorn bread (*kalg* or *kezke*) is traditionally eaten with dairy products (yoghurt, curd and butter), or meat products (broth, sheep head and kebab), or wild vegetables

It's a flatbread!

ACORN2024

Traditional use in Apulia region

A recent survey carried out within the Medacornet project rescued the following **traditional food use** of acorns in Apulia, dating back to the early 1900s):

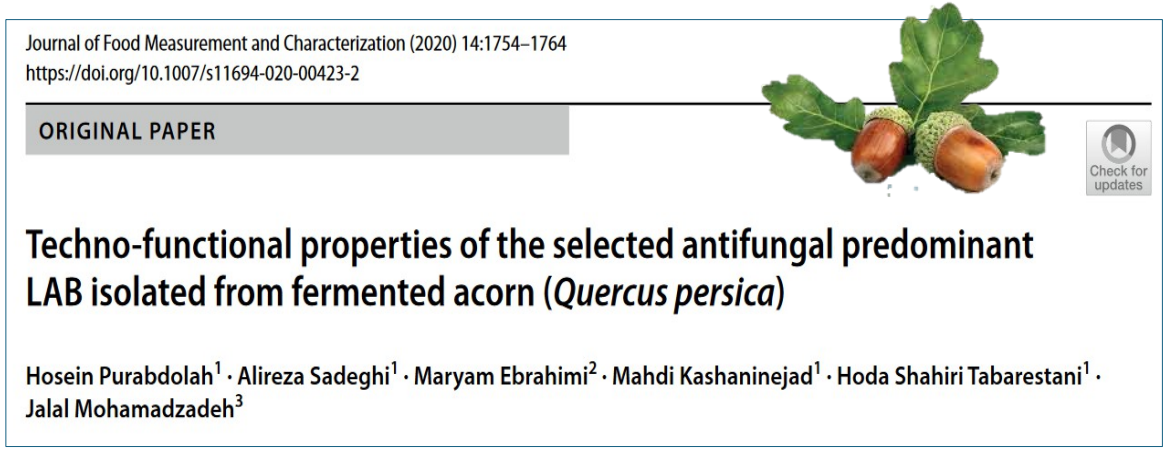
- **Flour** (after spontaneous leaching of acorns for about one month changing water until clear)
- **Bread** (**a kind of pancake** made of 100% acorn flour, to be eaten **warm**, immediately after preparation)
- **Coffee substitute** (made by toasted acorns, then shelling and grinding them. Prepared by boiling and filtering)

ACORN2024

Improvement of acorn bread quality

Modern consumers expect for better sensory properties. To improve them:

- Add **hydrocolloids** to ensure proper volume
- **Mix acorn flour (15-30% max) with wheat flour**, to reduce the negative impact on the rheological properties of dough
- Use **acorn sourdough**, prepared with selected autochthonous LAB


Journal of Food Measurement and Characterization (2020) 14:1754–1764
https://doi.org/10.1007/s11694-020-00423-2

ORIGINAL PAPER

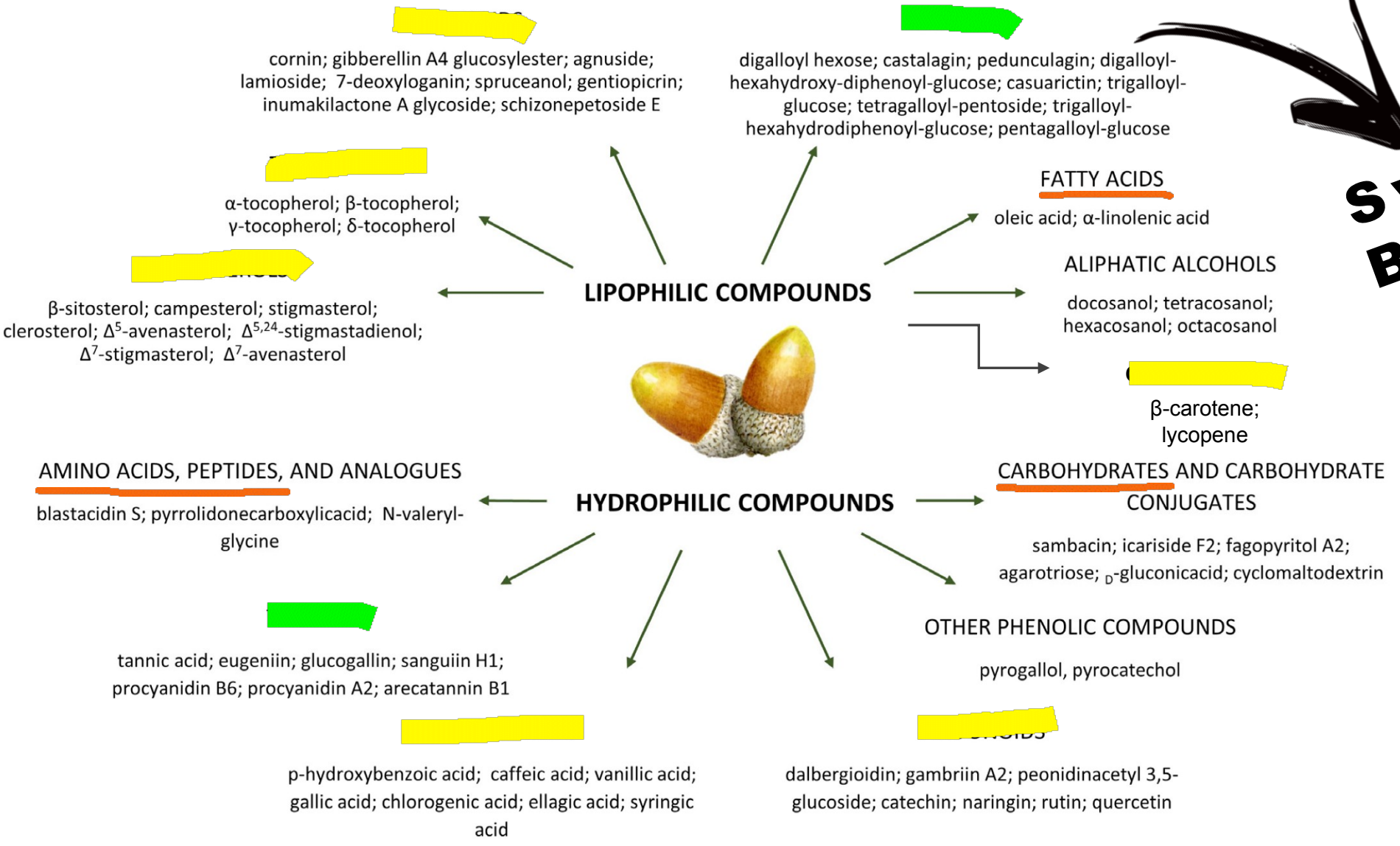
Check for updates

Techno-functional properties of the selected antifungal predominant LAB isolated from fermented acorn (*Quercus persica*)

Hosein Purabdolah[1] · Alireza Sadeghi[1] · Maryam Ebrahimi[2] · Mahdi Kashaninejad[1] · Hoda Shahiri Tabarestani[1] · Jalal Mohamadzadeh[3]

ACORN2024

Bioactives and nutrients of



Sweet vs Bitter

ACORN2024

Composition and antioxidant characterization of three oak species grown in Apulia

ACORN2024

Q. ilex L. (LECCIO)

Leaves with a lanceolate to oval shape

Brown **acorns** 1.5-2 cm long, oval

DIFFUSION

- Coastal and sub-coastal territories, inland Apennine and pre-alpine areas.
- In Apulia, from Gargano to Salento

Q. pubescens W. (ROVERELLA)

Leaves with long, lobed, curled or wavy margins

Acorns tight ovoid shape, arranged in pairs on the same stem

DIFFUSION

- All over Italy
- Pure woods in the city of Altamura, Andria, Grumo appula, Ruvo di Puglia, Terlizzi, Foggia

Q. trojana W. (FRAGNO)

Leaves oval, elliptic or narrowly oblong, with toothed margins

Acorns massive, with a hint of hairiness on the capsule

DIFFUSION

- Northeastern Mediterranean
- Typical of the Apulian and Lucanian Murgia

ACORN2024

MATERIALS AND METHODS

Sampling of acorns from three oak species

Four collection sites, in the Apulia region of Southern Italy, located NW, SW and SE of the capital town, Bari

A) ***Quercus pubescens* W. (Roverella)** - masseria La Ferrata - **Ruvo di**

B) ***Quercus ilex* L. (Leccio)** - masseria Trazzonara - **Martina Franca** (Taranto)

C) ***Quercus trojana* W.** (Fragno) - masseria Pezze Mammarella - **Martina Franca** (Taranto)

D) ***Quercus trojan***

Received: 31 July 2020 | Revised: 31 October 2020 | Accepted: 18 November 2020
DOI: 10.1111/1541-4337.12683
COMPREHENSIVE REVIEWS IN FOOD SCIENCE AND FOOD SAFETY

Proximate composition

Acorn flour properties depending on the production method and laboratory baking test results: A review

Emilia Szabłowska[1] | Małgorzata Tańska[2]

TABLE 3 Chemical composition of acorn flour and conventional cereal flours

Compound	Acorn flour	Wheat flour		Rye flour		Buckwheat flour	Oat flour	Corn flour
		Whole	White	Whole	White			
Water (%)	5.4 to 22.05	6.55 to 11.7	13.7 to 14.5	11.5 to 14.5	11.1 to 14.5	4.65 to 11.7	5.03 to 10.52	10.9 to 11.4
Carbohydrates (%)	75.22 to 84.09	69.5 to 73.03	71 to 71.3	74 to 77	76.68 to 77.4	66 to 73.52	61 to 61.51	71.14 to 76.9
Sugars (%)	n.d.	2.1	1.7	2.31	0.93	n.d.	n.d.	0.6
Proteins (%)	4.32 to 5	9.5 to 13.9	7.8 to 12.6	7.31 to 9.6	5.9 to 6.28	8.73 to 17.4	6.91 to 21.5	5.5 to 6.9
Lipids (%)	8.44 to 13.86	1.3 to 3.6	1.33 to 1.8	1.28 to 2.3	1.7 to 1.9	1.81 to 3.04	4.42 to 6.1	1.22 to 3.9
Main fatty acids (% of all fatty acids)								
Palmitic acid	14.09 to 14.98	14.2 to 27.5	18.17 to 19.74	15.95 to 19.41	15.43 to 15.99	14.3 to 15.78	16.5 to 20.62	12.62 to 14.4
Stearic acid	2.33 to 3.27	0.75 to 2.3	1.04 to 10.41	0.52 to 0.56	0.56 to 0.58	1.7 to 2.08	1.71 to 2	2.07 to 3.2
Oleic acid	59.85 to 60.92	12.73 to 24	15.5 to 31.14	16.39 to 17.34	16.48 to 18.05	34.9 to 36.53	39.2 to 41.85	26.08 to 34.4
Linoleic acid	15.34 to 15.91	49.1 to 61.36	23.74 to 61	54.58 to 56.22	56.09 to 56.17	33.01 to 38.6	26.56 to 38.5	45.2 to 54.73
Linolenic acid	0.63 to 0.84	3.94 to 5.04	1.74 to 3.71	7.15 to 9.19	7.93 to 9.3	2.5 to 3.78	0.71 to 1.4	0.9 to 2.08
Fiber (%)	10.89 to 17.9	4.5 to 12.82	2.9 to 3.9	16.71 to 12.8	6.40 to 8	0.7 to 2.18	4.05 to 6.16	2.62 to 7.3

- The acorn flours are suitable for the fortification of foods with the aim to increase the **fiber** content;
- The protein content in acorn flour is comparable with corn flour and from two to three times lower than in whole rye, wheat and oat flour. The acorn flour is **gluten free**, so acorn flours offers an alternative to other gluten free flours used to produce GF products

Received: 31 July 2020 | Revised: 31 October 2020 | Accepted: 18 November 2020
DOI: 10.1111/1541-4337.12683
COMPREHENSIVE REVIEWS IN FOOD SCIENCE AND FOOD SAFETY
Comprehensive REVIEWS WILEY

Acorn flour properties depending on the production method and laboratory baking test results: A review

Emilia Szabłowska[1] | Małgorzata Tańska[2]

Proximate composition

TABLE 3 Chemical composition of acorn flour and conventional cereal flours

Compound	Acorn flour	Wheat flour		Rye flour		Buckwheat flour	Oat flour	Corn flour
		Whole	White	Whole	White			
Water (%)	5.4 to 22.05	6.55 to 11.7	13.7 to 14.5	11.5 to 14.5	11.1 to 14.5	4.65 to 11.7	5.03 to 10.52	10.9 to 11.4
Carbohydrates (%)	75.22 to 84.09	69.5 to 73.03	71 to 71.3	74 to 77	76.68 to 77.4	66 to 73.52	61 to 61.51	71.14 to 76.9
Sugars (%)	n.d.	2.1	1.7	2.31	0.93	n.d.	n.d.	0.6
Proteins (%)	4.32 to 5	9.5 to 13.9	7.8 to 12.6	7.31 to 9.6	5.9 to 6.28	8.73 to 17.4	6.91 to 21.5	5.5 to 6.9
Lipids (%)	8.44 to 13.86	1.3 to 3.6	1.33 to 1.8	1.28 to 2.3	1.7 to 1.9	1.81 to 3.04	4.42 to 6.1	1.22 to 3.9
Main fatty acids (% of all fatty acids)								
Palmitic acid	14.09 to 14.98	14.2 to 27.5	18.17 to 19.74	15.95 to 19.41	15.43 to 15.99	14.3 to 15.78	16.5 to 20.62	12.62 to 14.4
Stearic acid	2.33 to 3.27	0.75 to 2.3	1.04 to 10.41	0.52 to 0.56	0.56 to 0.58	1.7 to 2.08	1.71 to 2	2.07 to 3.2
Oleic acid	59.85 to 60.92	12.73 to 24	15.5 to 31.14	16.39 to 17.34	16.48 to 18.05	34.9 to 36.53	39.2 to 41.85	26.08 to 34.4
Linoleic acid	15.34 to 15.91	49.1 to 61.36	23.74 to 61	54.58 to 56.22	56.09 to 56.17	33.01 to 38.6	26.56 to 38.5	45.2 to 54.73
Linolenic acid	0.63 to 0.84	3.94 to 5.04	1.74 to 3.71	7.15 to 9.19	7.93 to 9.3	2.5 to 3.78	0.71 to 1.4	0.9 to 2.08
Fiber (%)	10.89 to 17.9	4.5 to 12.82	2.9 to 3.9	16.71 to 12.8	6.40 to 8	0.7 to 2.18	4.05 to 6.16	2.62 to 7.3

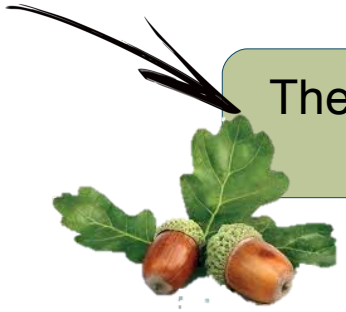
The acorn flours are characterized by higher **lipid content** respect to the conventional cereal flours. This is an important aspect that makes the acorn flours suitable for food formulation in which oils was added. When refined oils are added in the formulation a general improvement on the quality of the lipid fraction could be reached.

Proximate composition

The chemical composition of the acorn flour is influenced by the species and the environmental conditions

Parameter (g/100 g d.m.)	*Quercus ilex* L. (Leccio)	*Quercus pubescens* W. (Roverella)	*Quercus trojana* W. (Fragno - Santeramo)	*Quercus trojana* W. (Fragno - Martina)
Lipid	**5.21±0.08b**	**5.39±0.04b**	3.67±0.35c	6.23±0.15a
Ashes	**1.94±0.18ab**	**2.32±0.03a**	**2.13±0.18ab**	**1.78±0.18b**
Carbohydrates	**89.60±0.15a**	**85.87±0.24d**	**88.73±0.48b**	**86.63±0.11c**
Fiber	**7.35±0.97d**	**11.57±0.36b**	**9.56±0.17c**	**14.52±0.31a**
Protein	**3.26±0.11c**	6.42±0.17a	**5.47±0.04b**	**5.36±0.08b**

Different letters in the same row indicate significant differences at $p < 0.05$.



The main amino acids were **Aspartic acid** and **Glutamic acid**

Aminoacid composition

FAO/WHO (2013) amino acid reference pattern of proteins for adult diet. Values are given as % of protein. Each amino acid in the reference pattern was presumed to score a value = 100. Values are expressed relatively to the reference pattern

Amino acid	Reference pattern	Quercus ilex (Leccio)	Quercus pubescens (Roverella)	Quercus trojana (Fragno, Santeramo)	Quercus trojana (Fragno, Martina)
His	1.6	507.19	470.15	379.01	790.41
Thr	2.5	207.42	112.86	143.11	237.21
Cys	2.3	341.25	165.93	219.95	220.90
Val	4	121.28	114.80	121.13	114.47
Phe	4.1	194.03	104.48	129.50	172.57
Iso	3	174.75	144.54	164.19	148.86
Leu	6.1	122.09	142.85	124.99	99.29
Lys	4.8	53.63	72.85	43.58	81.12

Fatty acid composition

Fatty acids %	*Quercus ilex* L. (Leccio)	*Quercus pubescens* W. (Roverella)	*Quercus trojana* W. (Fragno - Santeramo)	*Quercus trojana* W. (Fragno - Martina)
C13:0	0.14±0.01a	0.12±0.00a	0.11±0.00a	0.17±0.04a
C14:0	0.12±0.01b	0.08±0.00c	0.11±0.02bc	0.20±0.01a
C14:1	0.12±0.00b	0.05±0.00c	0.05±0.00c	0.29±0.05a
C16:0	19.61±0.08a	14.98±0.12b	19.41±0.19a	14.06±0.15c
C16:1	0.32±0.00a	0.11±0.00b	0.14±0.00b	0.18±0.05b
C17:0	0.14±0.00c	0.26±0.01a	0.14±0.01c	0.20±0.01b
C17:1	0.13±0.01ab	0.10±0.01b	0.16±0.02a	0.11±0.03b
C18:0	1.92±0.02b	1.85±0.02c	2.07±0.03a	1.67±0.01d
C18:1	57.42±0.05c	62.75±0.00a	58.53±0.21b	62.04±0.37a
C18:2T	0.43±0.00a	0.13±0.00c	0.14±0.01bc	0.21±0.06b
C18:2	17.79±0.13bc	17.87±0.07b	17.15±0.06c	18.96±0.10a
C18:3 (n-3)	1.40±0.01c	1.36±0.02c	1.69±0.06a	1.60±0.04b
C20:0	0.23±0.03bc	0.29±0.00a	0.24±0.02b	0.19±0.00c
C20:1	0.22±0.00a	0.05±0.00c	0.05±0.00c	0.13±0.04b

%	*Quercus ilex* L. (Leccio)	*Quercus pubescens* W. (Roverella)	*Quercus trojana* W. (Fragno - Santeramo)	*Quercus trojana* W. (Fragno - Martina)
∑MUFA	58.22±0.05c	63.05±0.00a	58.93±0.81b	62.75±0.19a
∑PUFA	19.63±0.13b	19.36±0.09b	18.99±0.01b	20.77±0.01a
∑SFA	22.15±0.08a	17.59±0.09b	22.08±0.19a	16.49±0.20c

∑SFA, sum of saturated fatty acids; ∑MUFA, sum of monounsaturated fatty acids; ∑PUFA, sum of polyunsaturated fatty acids.
Different letters in the same row indicate significant differences at $p < 0.05$.

ACORN2024

Fatty acid composition and storage condition

Work package number	4	Lead beneficiary			UBA					
Work package title	Study of storage and conservation conditions of acorn flours and granulates									
Participant number	1	2	3	4	**5**	6	7	8	9	10	11
Participant short name	LT	IPLei	IPB	MORE	**UBA**	UO	BU	UAE	UTM	MECAC	GEOAI
PM/participant	0	2	0	0	**9**	0	0	0	0	0	0
Start month	09				**End month**	36					
Objectives: WP4 aims to: i) optimise the storage and conservation conditions of acorn flours and granulates produced in WP2; ii) monitor the potential oxidative degradation of the products during storage; iii) assess the secondary shelf-life of the products.											

ACORN2024

Bioactive compounds

Food Research International 114 (2018) 208–213

Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Antioxidant activity, tocopherols and polyphenols of acornoil obtained from *Quercus* species grown in Algeria

Fatima Z. Makhlouf[a], Giacomo Squeo[b], Malika Barkat[a], Antonio Trani[c], Francesco Caponio[b,*]

[a] Laboratoire Bioqual, INATAA, Université Frères Mentouri Constantine 1, Route de Ain El-Bey, 25000 Constantine, Algeria
[b] Department of Soil, Plant and Food Sciences, Food Science and Technology Unit, University of Bari Aldo Moro, Via Amendola, 165/A, 70126 Bari, Italy
[c] CIHEAM, International Center for Advanced Mediterranean Agronomic Studies of Bari, Laboratory of Environmental and Agricultural Chemistry, Via Ceglie, 9, 70010, Valenzano, Bari, Italy

Table 2. Concentration of tocopherols, phenolics and pigments in *Quercus* oils (mg kg^{-1} oil).

Tocopherols	QI	QS	QC
α-tocopherol	244.66 ± 6.51[a]	126.9 ± 5.25[c]	138.09 ± 4.64[b]
(β+γ)-tocopherols	403.59 ± 5.87[b]	389.60 ± 4.42[c]	422.02 ± 2.42[a]
δ-tocopherol	16.33 ± 0.90[b]	13.66 ± 1.61[c]	19.73 ± 0.33[a]
Total tocopherols	664.58 ± 13.29[a]	530.16 ± 11.32[c]	579.84 ± 7.41[b]
TPC*	121.32 ± 10.90[c]	187.60 ± 9.14[b]	299.29 ± 13.60[a]
Chlorophylls	1.88 ± 0.01[b]	2.03 ± 0.01[a]	1.10 ± 0.02[c]
Carotenoids	42.29 ± 1.46[b]	66.33 ± 0.90[a]	43.13 ± 0.60[b]

QI, *Quercus ilex* L.; QS, *Quercus suber* L.; QC, *Quercus coccifera* L.

Acorns present a relevant **antioxidant activity**

Compounds:

- **Hydrophilic** → **Phenols**
- **Lipophilic** → **Tocopherols**

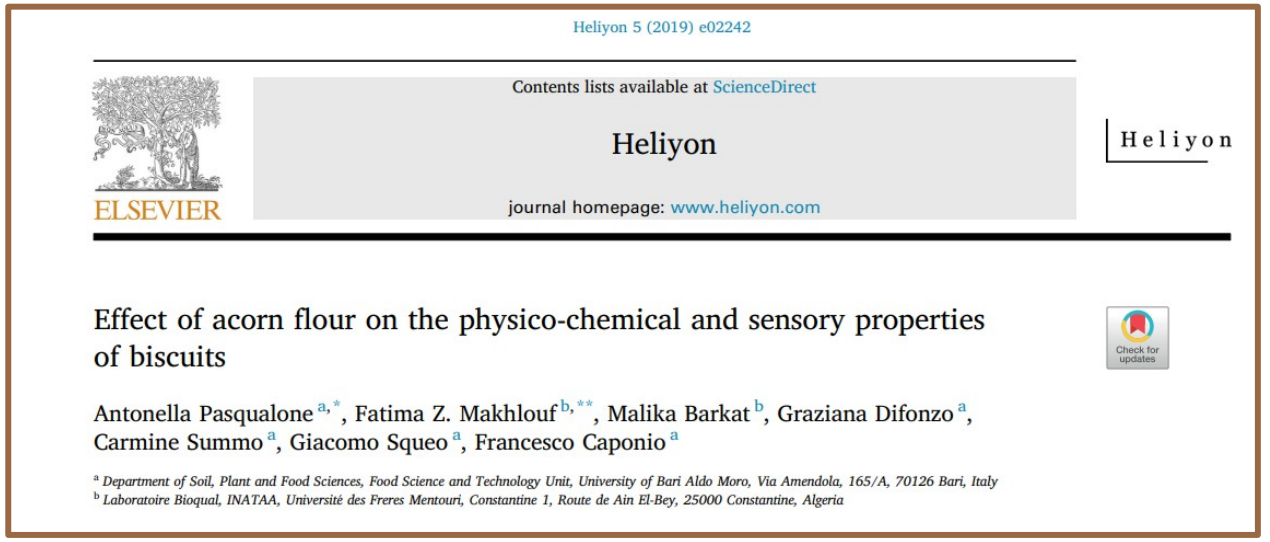
Bioactive compounds

Bioactive compounds	*Quercus ilex* L. (Leccio)	*Quercus pubescens* W. (Roverella)	*Quercus trojana* W. (Fragno - Santerama)	*Quercus trojana* W. (Fragno - Martina)
TPC (mg GAE/g d.m.)	55.78±2.72a	18.15±0.55c	22.95±1.89b	20.01±0.07bc
DPPH (µmol TE/g d.m.)	233.84±5.21a	147.93±2.53bc	143.94±13.99c	164.07±0.59b
ABTS (µmol TE/g d.m.)	130.00±2.87a	45.54±0.77c	57.12±1.98b	46.30±1.23c
β+γ-tocoferols (mg/kg of oil)	3206.32±147.61a	2191.53±21.97b	2037.14±0.10bc	1934.18±18.70c

TPC = Total phenolic content; T.E. = Trolox equivalents; DPPH = 2.2-diphenyl-1-picrylhydrazylcrylhydrazyl; ABTS =2.2'-azino-bis-3-ethylbenzthiazoline-6-sulphonic acid. Different letters in the same row indicate significant differences at $p < 0.05$.

ACORN FLOUR

Acorn flour is a **novel and healthy ingredient**, potentially applicable in food formulations.
In the present study **biscuits** with acorn flour were proposed



Heliyon 5 (2019) e02242

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.heliyon.com

ELSEVIER

Heliyon

Effect of acorn flour on the physico-chemical and sensory properties of biscuits

Antonella Pasqualone [a,*], Fatima Z. Makhlouf [b,**], Malika Barkat [b], Graziana Difonzo [a], Carmine Summo [a], Giacomo Squeo [a], Francesco Caponio [a]

[a] Department of Soil, Plant and Food Sciences, Food Science and Technology Unit, University of Bari Aldo Moro, Via Amendola, 165/A, 70126 Bari, Italy
[b] Laboratoire Bioqual, INATAA, Université des Freres Mentouri, Constantine 1, Route de Ain El-Bey, 25000 Constantine, Algeria

HIGHLIGHTS

Biscuits formulated with 30% or 60% of acorn flours from *Quercus coccifera* L. were characterized by higher content of **phenolics, antioxidant activity and oxidative stability** than control biscuits, prepared without acorn flour

CONCLUSIONS

- The **nutritional composition** of the acorn flours is influenced by several botanical and environmental factors that makes the composition **variable**.

- The high **fiber** content makes the acorn flours suitable for the fortification of bakery foods with the aim to increase the fibre content.

- The high amount and **good quality of the lipid fraction**, in terms of fatty acid composition, makes acorn flour potentially applicable to products that typically include oils in their formulation.

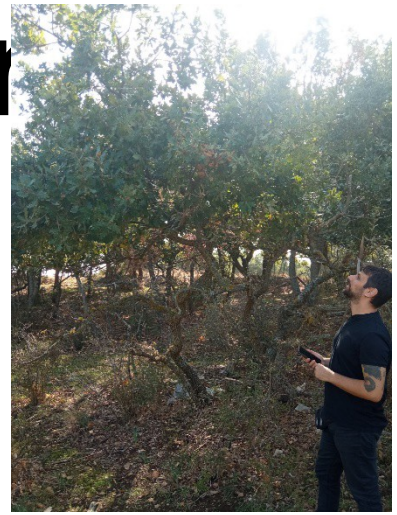
CONCLUSIONS

- The **absence of gluten** in the protein fraction is an interesting aspect for the use of the acorn flours in **gluten free bakery products**.

- The high level of **bioactive compounds**, in particular **tocopherols** and **phenols**, is relevant for functional foods.

Thank you for your time and





UBA team: Carmine Summo, Antonella Pasqualone, Giacomo Squeo and Francesca Vurro

ACORN2024