



Fondo europeo agricolo
per lo sviluppo rurale:
*l'Europa investe
nelle zone rurali*



ATS

Ancient and modern grains: a comparison of physical properties



Background

Ancient wheat: varieties cultivated before the intensive selection programs occurred during the “Green Revolution”.



Development of modern varieties with high-yield
Reduction of susceptibility to disease and insects
Increase tolerance to environmental stress
Higher gluten content
Increase in technological quality



Decrease in genetic variability
Reduction of nutritional value
Characteristic aroma and flavor

AIM

To compare the physical properties of ancient and modern varieties of flour



Experimental design

FLOUR CHARACTERIZATION

Chemical composition
Moisture content
Gluten content
Hydratation indexes
Colour properties
Granulometric analysis
Farinograph analysis



DOUGH PREPARATION AND CHARACTERIZATION

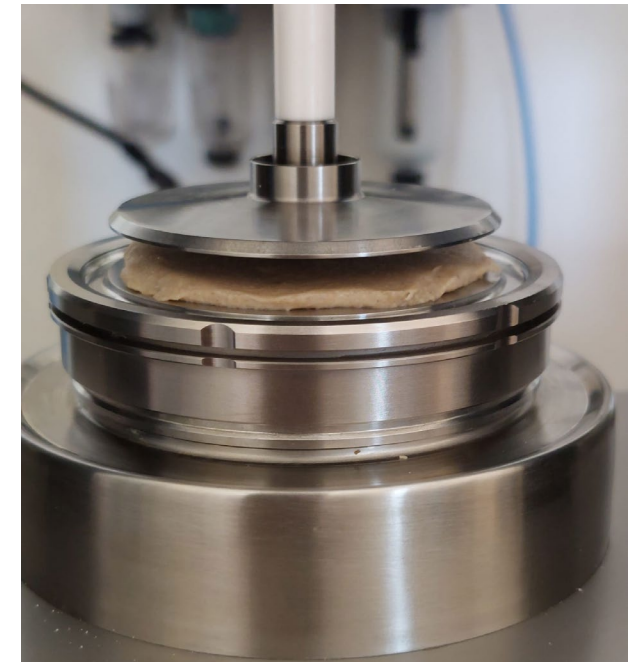


Water absorption
mixing time
dough stability





Rheological analysis:

Strain sweep ($\gamma\%=0.01-100$, $f=1$ Hz)
Creep recovery ($\tau = 10$ Pa)



Results: Chemical composition

Tab. 1 - Chemical composition of ancient and modern flours.

SAMPLES	Moisture %	Protein %	Fiber %	Fat %	Carbohydrate %	Wet Gluten %	Dry Gluten %
 A1	10.47 ^c	10.89 ^d	12.32 ^d	1.63 ^c	62.17 ^b	19 ^c ±0.47	5.87 ^b ±0.15
A2	10.08 ^b	10.21 ^b	6.62 ^b	1.40 ^b	69.2 ^e	13.71 ^a ±0.55	4.88 ^a ±0.20
A3	10.39 ^c	10.26 ^c	4.15 ^{ab}	1.10 ^a	72.16 ^f	15.07 ^b ±0.25	5.18 ^a ±0.02
A4	9.41 ^a	9.77 ^a	3.13 ^a	1.11 ^a	73.62 ^g	17.92 ^c ±0.49	6.53 ^c ±0.24
 M1	10.74 ^d	12.23 ^f	8.53 ^c	2.3 ^e	61.63 ^a	27.07 ^d ±1.17	9.97 ^d ±0.48
M2	11.44 ^e	10.89 ^d	8.43 ^c	1.83 ^d	67.97 ^d	34.22 ^e ±1.14	12.96 ^e ±0.44
M3	12.58 ^f	10.89 ^d	6.77 ^b	1.4 ^b	70.53 ^{ef}	34.38 ^e ±0.49	12.86 ^e ±0.23
M4	11.27 ^e	14.03 ^g	4.7 ^{ab}	1.7 ^{cd}	67.1 ^c	43.3 ^f ±0.99	16.56 ^f ±0.29

Results: Granulometric analysis

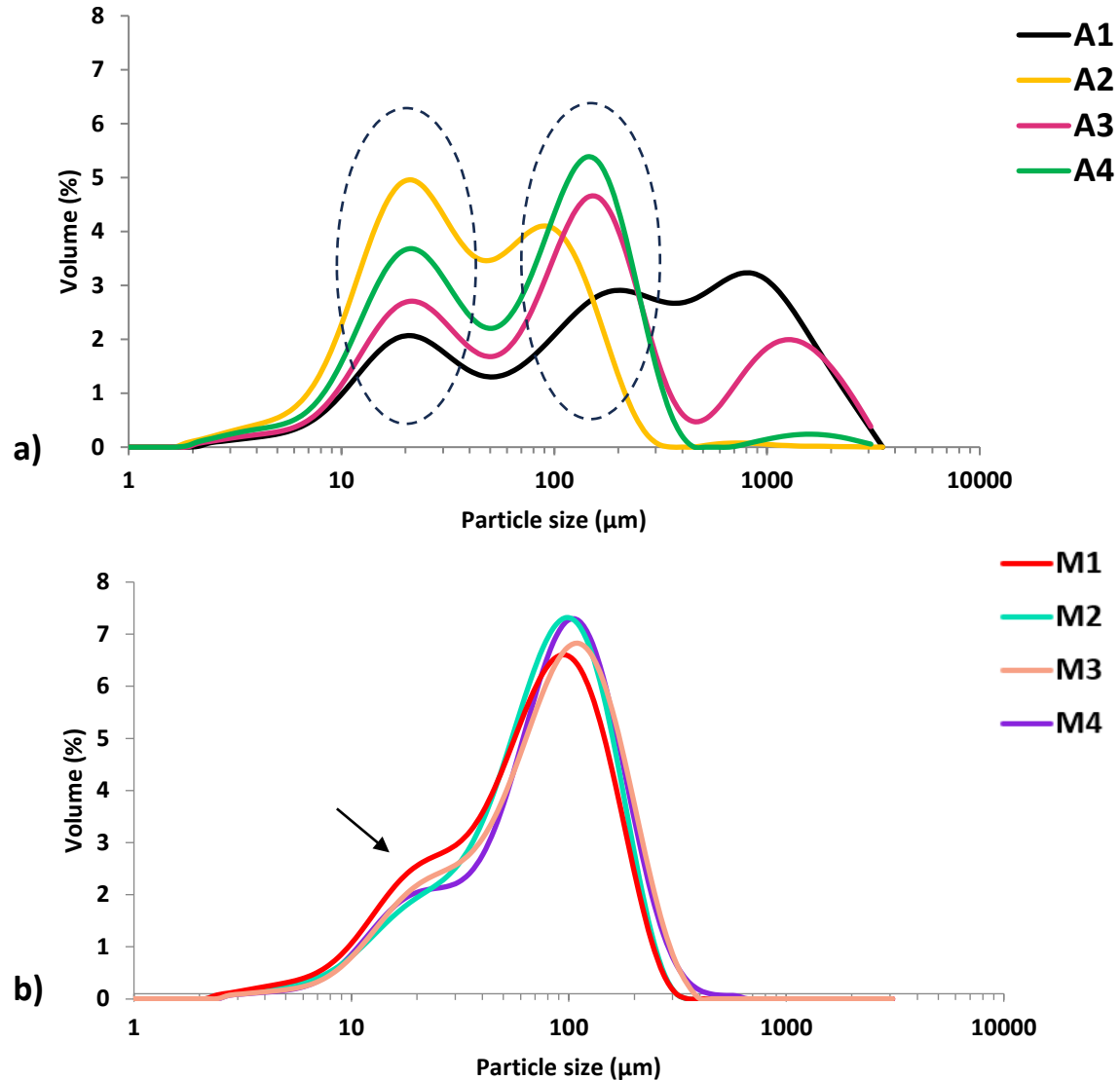


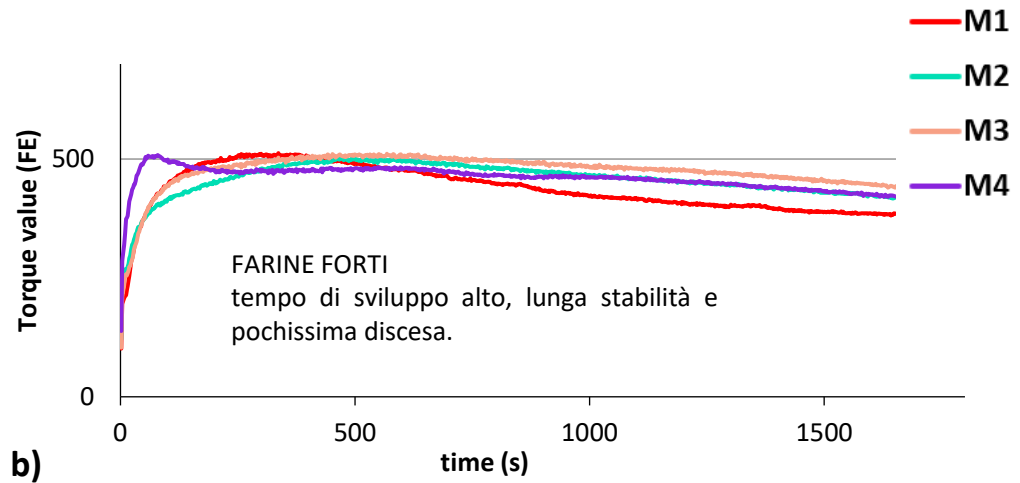
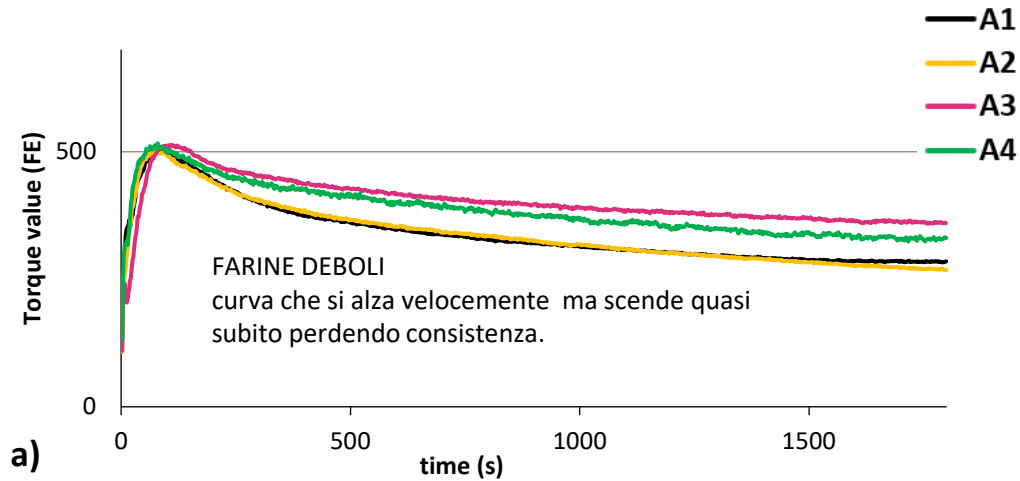


Fig. 1 – Particle size distributions (PSD) of ancient (a) and modern (b) flours.

Tab. 2 – D_{10} , D_{50} and D_{90} of ancient and modern flours.

SAMPLES	D_{10} (μm)	D_{50} (μm)	D_{90} (μm)
A1 	18.13 ± 0.15^b	238.67 ± 5.51^e	1380 ± 10^g
A2	15.93 ± 0.06^{ab}	186 ± 0.02^d	1260 ± 20^f
A3	15.70 ± 0.01^a	336.33 ± 0.47^a	841.33 ± 3.05^d
A4	13.10 ± 0.10^a	85.57 ± 0.96^b	935.33 ± 3.05^e
M1 	20.01 ± 0.17^{bc}	88 ± 1.738^b	197.42 ± 10.07^a
M2	24.47 ± 0.12^d	192.33 ± 0.58^d	620.33 ± 11.55^c
M3	18.43 ± 0.06^b	93.73 ± 0.57^c	335.3 ± 0.583^b
M4	21.87 ± 0.06^c	80.33 ± 0.58^a	174.67 ± 15.14^a

Results: Farinographic analysis



Tab. 3 – Farinograph characteristics of ancient and modern flours.

SAMPLES	WZ%	DDT (min)	S (min)	DS
A1	66.03 ±0.15 ^g	1.32 ±0.01 ^b	1.50 ±0.08 ^a	91 ±2 ^d
A2	60.06 ±0.15 ^d	0.89 ±0.28 ^a	1.91±0.28 ^a	107.67 ±5.69 ^e
A3	59.73 ±0.15 ^c	1.16 ±0.08 ^{ab}	1.69 ±0.30 ^a	148.67±5.51 ^g
A4	57.80 ±0.2 ^b	1.07 ±0.03 ^{ab}	1.54 ±0.04 ^a	140.67±3.05 ^f
M1	64.3 ±0.17 ^e	4.23 ±0.02 ^c	7.22 ±0.76 ^b	29 ±2.65 ^c
M2	64.5±0.10 ^{ef}	7.30 ±0.09 ^d	11.32 ±0.19 ^c	0.67 ±0.57 ^a
M3	56.03 ±0.12 ^a	0.90 ±0.27 ^a	11.51 ±0.59 ^c	22 ±5 ^b
M4	64.77 ±0.21 ^f	6.99 ±0.41 ^d	16.17 ±0.92 ^d	1 ^a

WZ% = assorbimento d'acqua DDT = tempo di sviluppo S = stabilità DS = grado di rammollimento



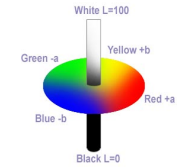
Flours that can also be kneaded with an excess of mechanical energy, without having major changes in the consistency of the dough and with reduced damage to the gluten.

Fig. 2 – Farinogram curves of ancient (a) and modern wheat flours (b).

Results: Hydration indices and colorimetric parameters

Tab. 4 – Hydration indices at 25°C and colorimetric parameters of ancient and modern flours.

SAMPLES	WAI	WSI %	SP	L	a	b
A1	2.15 ±0.05 ^e	6.15 ±0.19 ^b	2.29 ±0.05 ^e	91.1 ±0.09 ^b	0.94 ±0.09 ^e	8.56±0.06 ^b
A2	1.96 ±0.06 ^{bc}	5.64 ±0.22 ^a	2.08 ±0.07 ^{bc}	92.14 ±0.02 ^c	-0.82 ±0.08 ^b	9.13±0.13 ^{cd}
A3	1.88 ±0.01 ^{ab}	6.15 ±0.07 ^b	2±0.01 ^{ab}	97±0.26 ^f	-0.46 ±0.01 ^c	7.82±0.09 ^a
A4	1.87 ±0.02 ^a	5.40 ±0.24 ^a	1.97 ±0.01 ^a	94.65 ±0.10 ^e	-1.34 ±0.02 ^a	9.29±0.03 ^{de}
M1	2.07 ±0.08 ^{de}	6.56 ±0.21 ^c	2.22 ±0.09 ^{de}	85.76 ±0.37 ^a	1.31 ±0.09 ^f	10.02±0.2 ^f
M2	2.04 ±0.06 ^{cd}	6.88 ±0.08 ^d	2.2 ±0.07 ^{de}	91.14 ±0.26 ^b	-0.26±0.04 ^d	9.50±0.21 ^e
M3	2.05 ±0.02 ^d	6.08 ±0.02 ^b	2.18 ±0.02 ^d	93.12 ±0.17 ^d	-0.84 ±0.02 ^b	9.51±0.14 ^e
M4	2 ±0.02 ^{cd}	6.21 ±0.09 ^b	2.13 ±0.02 ^{cd}	91.22±0.09 ^b	-0.39±0.05 ^c	9.03±0.13 ^c



Results: Rheological analysis

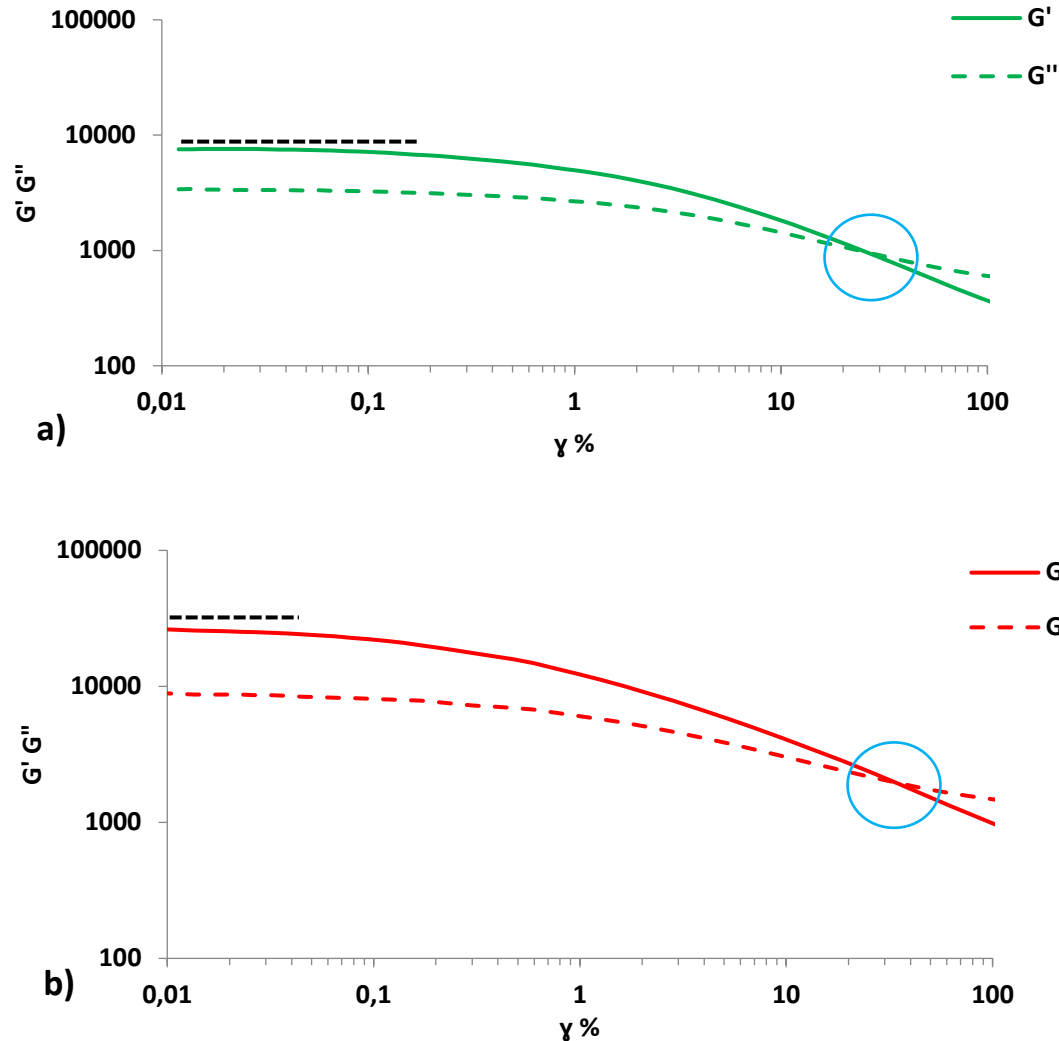


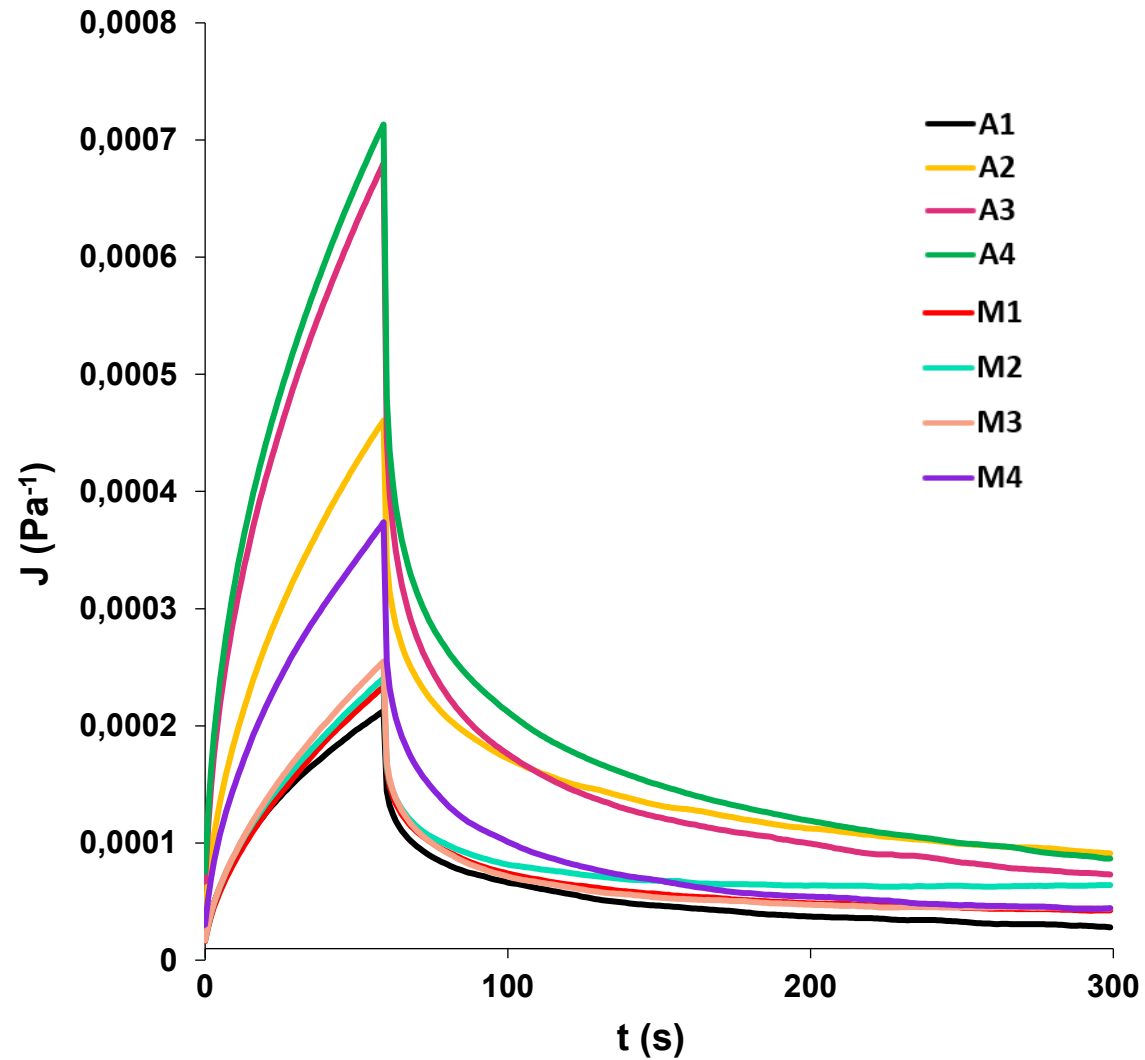


Fig 3 – Elastic modulus (G') and storage modulus (G'') as function of strain (γ %) of doughs from ancient (a) and modern (b) flours.

Tab. 5 – Strain sweeps of doughs from ancient and modern flours.

SAMPLES	γ_0 %	σ^* Pa	G' Pa	G'' Pa	η^* Pa·s	UR %
A1 	0.20 ^d	497.13 ^c	22252.8	8680.2	3801.6	45.57 + 0.09 ^e
A2	0.15 ^c	453.49 ^{bc}	14197	6252.3	2469	44.19 + 0.08 ^c
A3	0.15 ^c	325.85 ^{ab}	7277.3	3278.7	1270.3	43.15 + 0.17 ^a
A4	0.21 ^d	268.82 ^a	6241.7	2762.4	1086.3	42.99 + 0.1 ^a
M1 	0.05 ^a	859.36 ^d	25234.2	8736.5	4250.0	45.22 + 0.06 ^d
M2	0.11 ^b	1258.24 ^f	19564.9	6695.3	3291.2	45.86 + 0.15 ^f
M3	0.11 ^b	1258.37 ^f	17683.7	5827	2963.3	43.7 + 0.1 ^b
M4	0.12 ^b	1012.21 ^e	12554.4	4690.6	2133.2	46.18 + 0.12 ^g

Results: Rheological analysis



Tab. 6 – Creep Recovery test of doughs from ancient and modern flours.

SAMPLES	J_0	J_{max}	J_f
		$10^{-5} Pa^{-1}$	
A1	1.9 ^a	21.3 ^a	2.8 ^a
A2	3.9 ^c	46 ^c	9.1 ^c
A3	6.9 ^d	69.4 ^d	8.7 ^c
A4	7.6 ^d	71.7 ^d	6.9 ^b
M1	1.6 ^a	23.3 ^a	4.2 ^a
M2	1.7 ^a	24.1 ^a	6.4 ^b
M3	1.7 ^a	25.5 ^a	4.4 ^a
M4	3 ^b	37.4 ^b	4.4 ^a

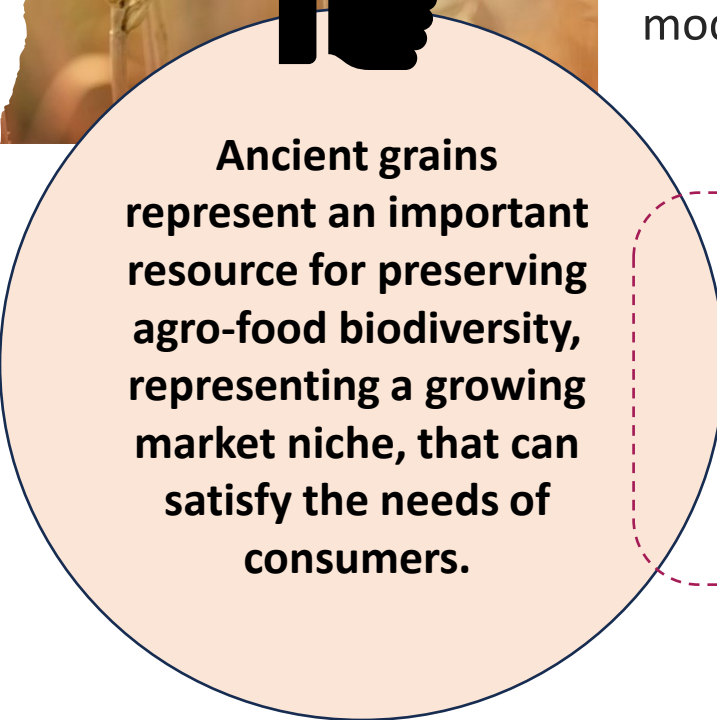
Final remarks

Ancient and modern flours showed comparable nutritional properties;

Modern flours had a more homogeneous and fine particle size than ancient ones;


Ancient flours showed typical farinogram of weak flours with short development times and low stability;

Doughs obtained from modern grains had greater elastic modules and were more rigid and stronger than those obtained from ancient grains.



Ancient grains represent an important resource for preserving agro-food biodiversity, representing a growing market niche, that can satisfy the needs of consumers.

New large-scale projects based on past experience, industrial and territory needs, but also on consumer health are required.



Modern grains are more suitable for the industrial production of bread, pasta and other baked products.