



Moisture content determination of some food commodities organically and conventionally grown

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Organic farming

■ Principle of health

- Should sustain and enhance the health of soil, plant, animal, human and planet

■ Principle of ecology

- Should be based on living ecological systems and cycles, work with them, emulate them, and help sustain them

■ Principle of fairness

- Should ensure fairness with regard to the common environment and life opportunities

■ Principle of care

- Should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment





Organic agriculture

- In European Union (2004): \pm 5.8 MHa, \pm 140,000 farms, 3.4 % agricultural area
- Organic food and drink market (2003): 13 billion US\$ in Western Europe; + 5%
- Policy support: Common Agricultural Policy reform, Action plans, European Research Area



Source: Printemps BIO / V. Gremillet





Organic agriculture

- The concept is codifying in various standards at international, national and private levels
- To maintain the credibility of the organic farming sectors:
 - Prior notification of the activity
 - Special inspection schemes
 - Certification & labelling systems
- But weaknesses:
 - Fraud cases popping up
 - No validated (analytical) methods to authenticate the organic food products





Organic agriculture

- **Any minor differences** associated with both production systems?
 - No clear conclusions but only some trends
 - Reasons: Few comparative studies, too old studies, insufficient valid experimental designs
- **Potential markers** for plant analysis
 - **Dry matter (O > C)**; Protein content (O < C) & quality (O > C); Nitrates (O < C); isotopes; Polyphenols (O > C); Vitamins (O > C)



More comparative studies are needed
No *a priori* selection of analytical methods



Determination of dry matter

Joint Research Centre

Vegetable	Studies	O > C	O = C	O < C
Salad	3	2	1	0
Cabbage	4	2	2	0
Potato	9	5	3	1
Carrot	7	2	4	1
Leek	2	1	0	1
Beet root	3	0	3	0
Celery (root)	1	1	0	0
Turnip	1	0	1	0
Onion	1	0	1	0
	31	13	15	3

Source:
AFSSA (2003)

- Global trend of similar or higher dry matter contents in organic vegetables
- **BUT** few reliable data and limited to some vegetables and fruits





Objectives

- To test several analytical methods for their efficiency in distinguishing organically grown food products from conventionally ones.
- To contribute to the European action plan for organic food and farming.



Methodology – Plant materials

■ Project ADAB – *Authentification de Denrées Alimentaires issues de l’Agriculture Biologique*



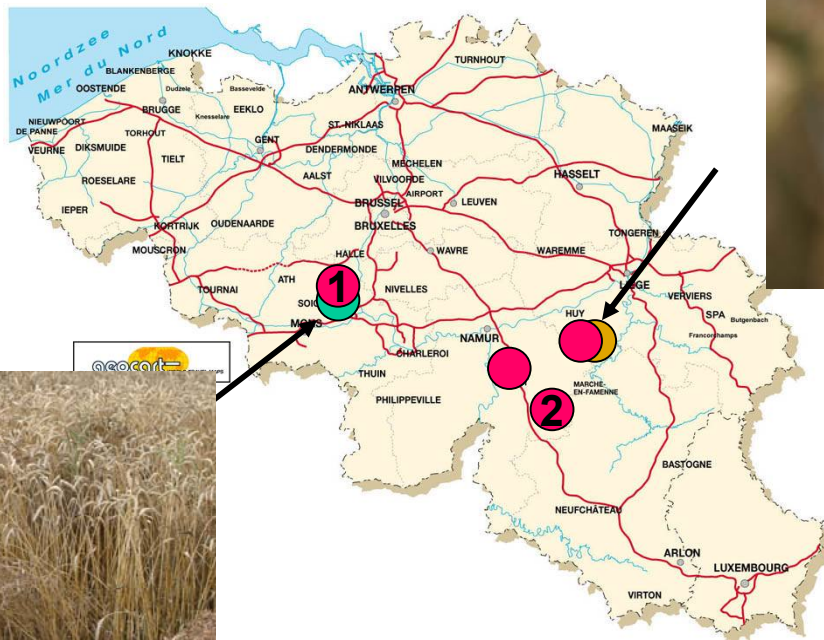
Joint Research Centre

	2004	2005	2006	2007
Winter wheat (grains)	Bussard / Monopol (O) & Napier (C)	Cubus	Cubus	-
Horse bean (seeds)	Gloria	Gloria	Gloria	-
Potato (tubers)	Charlotte	Charlotte	Charlotte	-
Carrot (roots)	Népal	Népal (C) & Nérac (O/C)	<i>Not yet selected</i>	-

Winter wheat (*Triticum aestivum*), grains



Mix. "Bussard – Monopol"
 Dist. O-C: 0.2 km



- Var. "Cubus"**
- Dist. O-C: 7.0 km
 - 1 Dist. O-C: 3.4 km
 - 2 Dist. O-C: 4.2 km

Field sites

- 2004
- 2005
- 2006





Methodology – Analytical methods

Method / Technique	Measurand	Year
Freeze drying	Moisture content	2004
Oven drying	Moisture content	2005
Karl Fischer Titration	Water content	2006

- Sample is peeled and cut into small pieces (< 1 cm)
- 5 g wet mass of sample is weighed
- For each crop, 15 samples are measured per agricultural system

■ Freeze-drying

- Lyovac GT 2 freeze-drying instrument
- Sample is previously freeze-dried at -30 °C during 2h
- Constant temperature (± 20 °C) and vacuum ($10^{-2} - 10^{-3}$ mbar)
- 18h drying time
- Verification of the constant vacuum value

■ Oven drying

- Oven thermostatically controlled at 105 ± 5 °C
- Overnight (± 16 h) drying time
- Verification of the constant mass





Results – Winter wheat

Joint Research Centre

Year	cv	DaS ¹	AS ²	Freeze-drying			Oven drying		
				\bar{X} (%)	SD	t-test	\bar{X} (%)	SD	t-test
2004	mix	259	O	11.2	0.3	< 0.001			
	Napier	258	C	60.6	1.8				
2005	Cubus	251	O	58.8	1.1	< 0.001			
		255	C	52.0	2.2				
		278	O	30.7	1.5	< 0.001	31.6	1.1	< 0.001
		282	C	33.9	1.0		34.6	0.9	

¹Nb of days after sowing date; ²Organic Farming (O), Conventional farming (C).

- Influence of the variety
- Before seed maturity, significant difference in moisture content but slight (10%)
- Good relation between both methods



Results – Horse bean

Year	DaS	AS	Freeze-drying		
			\bar{X} (%)	SD	t-test
2004	127	O	58.6	5.8	0.003
		C	49.5	8.9	
	141	O	15.4	3.0	0.768
		C	15.7	2.5	
2005	115	O	76.1	1.2	< 0.001
	112	C	74.1	1.5	
	155	O	15.4	1.2	0.284
	152	C	14.9	1.1	

¹Nb of days after sowing date; ²Organic Farming (O), Conventional farming (C).

■ No significant difference at seed maturity (both methods)

■ Asynchronous seed maturity influencing the measurements





Results - Potato

Year	DaS	AS	Freeze-drying			Oven drying		
			\bar{X} (%)	SD	t-test	\bar{X} (%)	SD	t-test
2004	73	O	79.5	2.0	0.002			
	69	C	83.5	3.8				
	114	O	67.7	2.8	0.006			
	110	C	71.1	3.2				
	140	O	77.8	1.0	< 0.001			
	136	C	80.6	1.5				
2005	142	O				75.6	1.8	0.085
	143	C				73.8	3.4	

¹Nb of days after sowing date; ²Organic Farming (O), Conventional farming (C).

- Tuber size influences the results
- No clear conclusion





Results - Carrot

Joint Research Centre

Year	cv	DaS	AS	Freeze-drying			Oven drying		
				\bar{X} (%)	SD	t-test	\bar{X} (%)	SD	t-test
2004	Népal	48	O	86.9	1.6	0.049			
		52	C	88.4	2.2				
		94	O	87.6	1.0	0.016			
		98	C	88.3	0.6				
		133	O	87.1	1.2	< 0.001			
		137	C	88.9	1.2				
		171	O	86.3	1.2	< 0.001			
2005	Nérac	157	O	87.6	0.8	0.045	87.1	1.1	0.386
		153	C	88.1	0.5		86.6	2.1	



- Moisture contents not influenced by the physiological stage & the size of the roots (Coeff. var.: $\leq 2.5\%$)
- No clear conclusion
- Good relation between both methods





Conclusions

- **Methods need to be standardised: organ size, homogeneity at one physiological stage**
- **Drawback of the “farm approach”: difficulty to keep the same variety through the growing seasons**
- **Moisture contents slightly higher (10%) in conventional wheat**
- **More data needed, analysing the same variety and the same physiological stage than the previous year(s)**
- **Preliminary results to be confirmed: in 2006 & 2007, samples from three environments per crop will be analysed**
- **Good relation between the results obtained by freeze-drying and by oven drying**
- **Karl Fischer Titration will be used as a confirmatory method**



Acknowledgements

- **Farmers**
- **Union nationale des agrobiologistes belges – UNAB**
- **Centre d'essais Bio – CEB**

THANK YOU

