WHEN YOU NEED TO BE SURE

SGS

Mycotoxins, MRL's & food chain contaminations

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WHEN YOU NEED TO BE SURE

SGS

Hazards associated with wheat & wheat processing (HACCP)

- Physical hazards
  - Glass, stones, metal,…
- Biological hazards
  - Insects, rodents,…
  - micro-organisms: bacteria, fungi / moulds
- Chemical hazards
  - Pesticide residues, mycotoxins, …

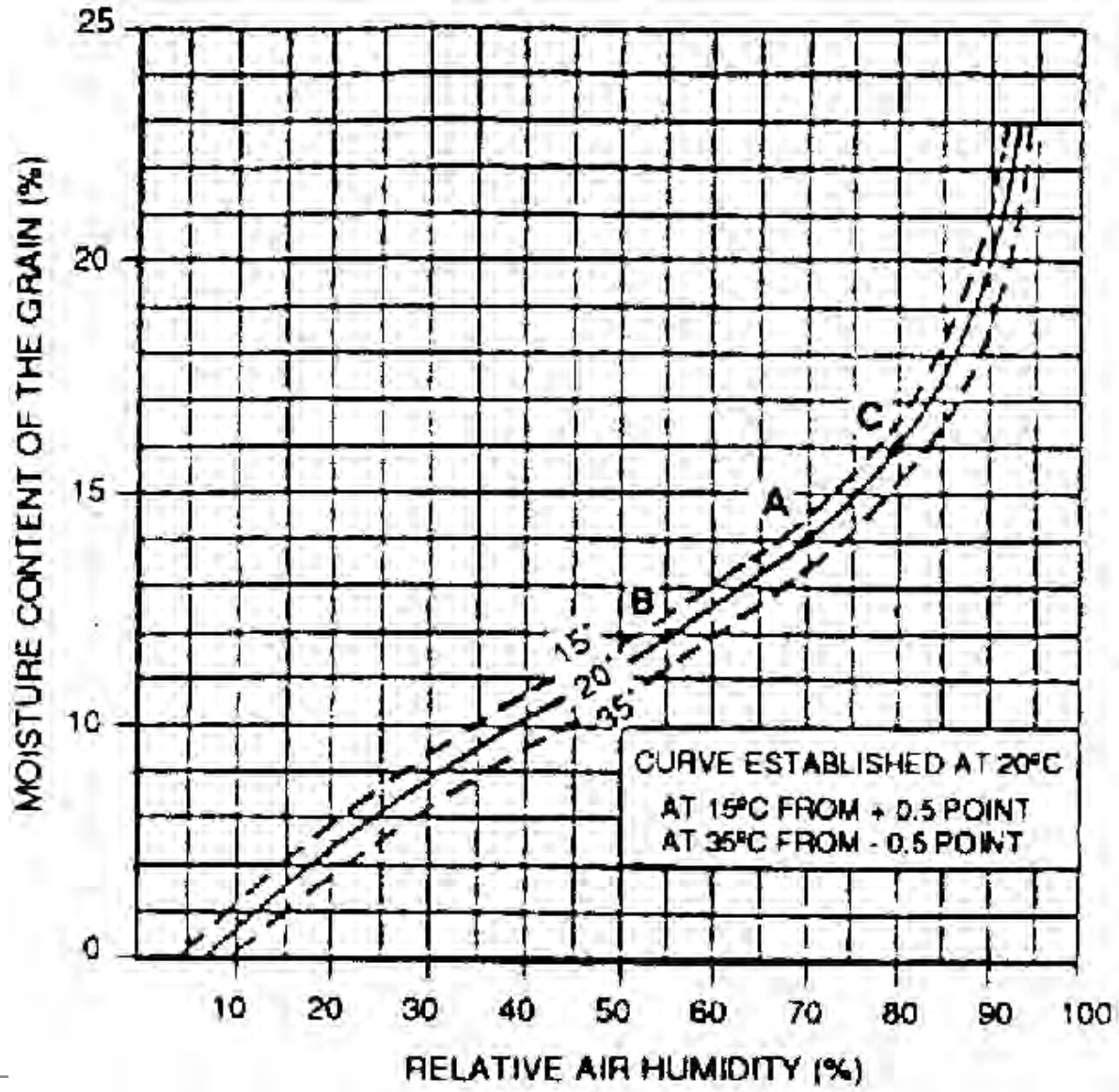
Rapid Alert System for Food & Feed

- Weekly bulletin of notifications (Alerts / Information) since 2003
- In 2006: 6840 notifications (934 alerts / 1989 info)
- In 2007: 7354 notifications (961 alerts / 2015 info)
- From 2006 till now ca. 700 notifications concerning cereals, oilseeds and their processed products
- Specific for wheat + wheat by products
  - 2006
    - Ochratoxin (OTA) ex Russia
  - 2007
    - OTA ex Russia & Kazakhstan
    - DON ex France
  - 2008
    - OTA ex Kazakhstan
    - DON ex Hungary & Germany
    - Zea ex Ukraine

Equilibrium moisture content of wheat

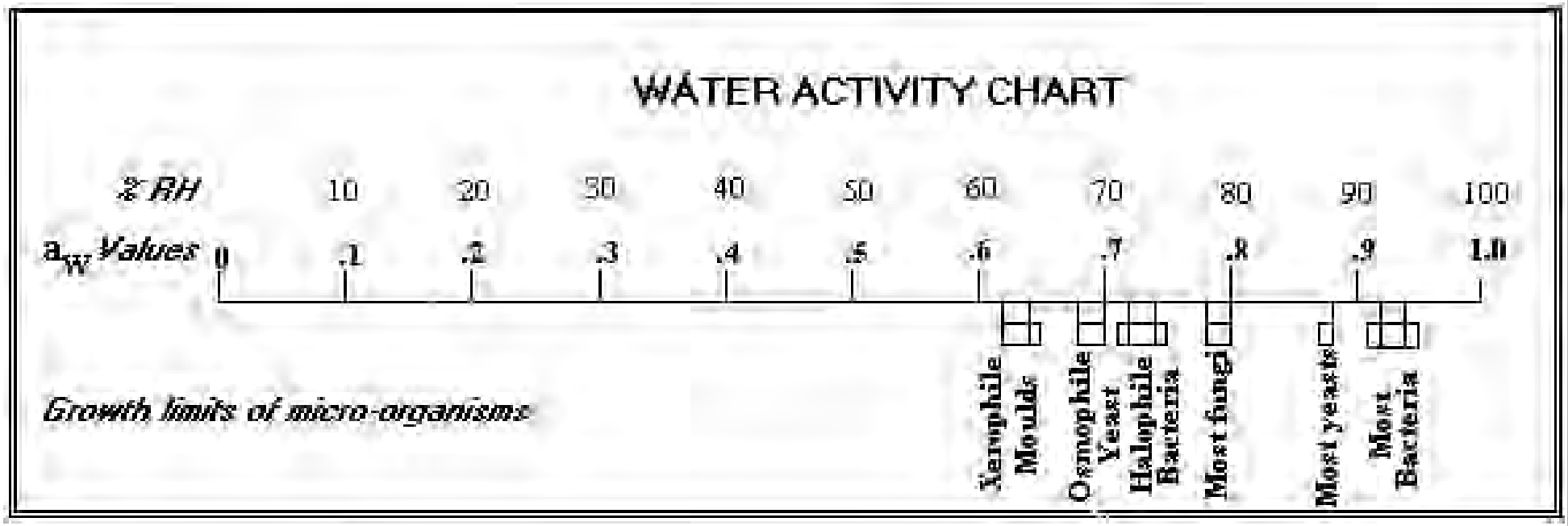
Equilibrium Moisture Content for Soft Winter Wheat Exposed to Air					
Temperature	**Relative Humidity %**				
°C (°F)	**50**	**60**	**70**	**80**	**90**
0 (32)	12.5	13.5	14.6	16.1	18.2
5 (41)	12.1	13.1	14.2	15.7	17.9
10 (50)	11.7	12.7	13.9	15.3	17.5
15 (59)	11.4	12.4	13.5	15	17.2
20 (68)	11.1	12.1	13.2	14.7	17
25 (77)	10.8	11.8	13	14.4	16.7

Equilibrium moisture content curve - maize



Water activity

- Water activity (Aw) = amount of water that is available to micro-organisms.
- Many micro-organisms prefer Aw of 0,99 and most need >0,91
- Aw is related to Relative Humidity (RH)
- Aw = RH / 100
- RH = availability of water in the atmosphere around the product


WATER ACTIVITY CHART
% RH
10
20
30
40
50
60
70
80
90
100
a_w Values
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
Growth limits of micro-organisms
Xerophile Moulds
Osmophile Yeast
Halophile Bacteria
Most fungi
Most yeasts
Most Bacteria

Micro-organisms

- Relevance of micro-organisms in cereal commodities
  - Bacteria
    - Salmonella spp.
  - Fungi
    - Aspergillus spp.
    - Penicillium spp.
    - Fusarium spp.

Bacteria

- Salmonella Spp
  - Salmonella Typhimurium
  - Salmonella Enteritidis

- Salmonellosis in humans
  - Enteric fever (typhoid): bacterial invasion in the bloodstream
  - Acute gastroenteritis

- + 2500 Serovars

Salmonella spp.

- Enterobacteriacea
- Principal habitat: intestinal tract of humans and animals
- Contamination via human or animal excretion, either if diseased or as carrier
- No important multiplication in an environment other than the digestive tract, but survival in water and/or soil if conditions of temperature, moisture and pH are favorable.
- Salmonella spp. needs
  - Aw > 0,95 (0,91)
  - $pH_{opt.}$ 7 pH > 4 (4,7)
  - $T_{opt.}$ 37°C 0°C < T < 55°C

Fungi - Mycotoxins

- In cereals, oilseeds and feedstuffs mainly produced by 5 families of moulds
  - Aspergillus (e.g. Aflatoxin, Ochratoxin)
  - Penicillium (e.g. Ochratoxin)
  - Fusarium (e.g. DON, ZEA, Fumonisins, T-2 & HT-2)
  - Claviceps (e.g. ergot)
  - Alternaria (e.g. Alternariol,...)
- Some moulds are able to produce more than one mycotoxin and some mycotoxins are produced by several mould species
- Presence of external signs of moulds gives no certainty about presence of mycotoxins.
- Thermostable compounds

Mycotoxins

What

Secondary metabolites of fungal origin that are toxic to animals and humans

When

- Formation during growing (field fungi)
- Formation during storage (storage fungi)

Toxicity

Depending on the kind of mycotoxin and the species. So far +300 different mycotoxins isolated.

Aflatoxin

- Aspergillus flavus toxin (+ A. parasiticus)
- First isolated in 1961 in UK: Turkey X-disease
- 6 metabolites B1, B2, G1, G2, M1 & M2
- Most commonly found in tree nuts, peanuts and oilseeds (incl. corn, rice and cottonseed)
- Toxicity in animals and humans
  - Acute toxic
  - Chronically toxic (liver)
- The most potent naturally occuring carcinogen in animals, with very strong link to human cancer incidence.

Aflatoxin

Ecology of Aspergillus flavus

T_{min}	15°C	
T_{opt}	35°C	
T_{max}	44°C	
A_w	min. 0,78	(storage)

Plants are attacked when in stress, e.g. for corn typical stress conditions for A.flavus invasion are drought and accompanying high temperatures during grain fill.

Aspergillus ear rot (aflatoxin)

Aflatoxin

Optimum conditions for aflatoxin production during storage

- Temperature: 25 – 32 °C
- Kernel moisture: > 15 % optimum 18-20 %
- RH: > 85 %

Insect infestation increases the chance for mycotoxins.

Chemical decontamination is possible.

Ochratoxin

- Aspergillus ochraceus (hot climates), but mainly Penicillium verrucosum (temperate & colder climates)
- Most commonly found in dried foods such as peanuts, pecans, beans, coffee, cocoa, dried (vine) fruits...
- Also found in barley and wheat crops infected in the field or in **storage**.
- Fat soluble: bio-accumulation + half-life time
- Pigs & poultry most sensitive
- Nefro-toxic

Ochratoxin

Ecology of A. ochraceus

T_{min}	15°C
T_{opt}	28°C
T_{max}	37°C
A_w	min 0,77 (storage fungi)

Ecology of Penicillium verrucosum @ Aw 0,95

T_{min}	0°C
T_{opt}	12-24°C
T_{max}	31°C
A_w	min 0,80 (storage fungi)

(Scandinavia, Baltic, Germany, N-America,...)

Fusarium toxins

- Trichothecenes
  - Deoxynivalenol (DON / Vomitoxin) (F. graminearum)
  - T-2 & HT-2 Toxin (F. tricinctum and F. roseum)
- Zearalenone (F. graminearum)
- Fumonisins (F. moniliforme)

- Temperate climates
- A_w min. **0,90** (field fungi)

- Toxicity : species dependent
- No carry-over

Fusarium toxins

Symptoms of Fusarium head blight of wheat

Maximum levels for aflatoxins & ochratoxin (EU)

Values fixed for unprocessed cereals for human consumption

MYCOTOXIN	Product	maximum levels (ppb)
Aflatoxin	Cereals for direct consumption or as ingredient in foodstuffs Cereals (excl. maize) to be subjected to sorting or physical treatment before human consumption	**2 B1** **4 B1+B2+B3+B4**
	Maize to be subjected to sorting or physical treatment before human consumption	**5 B1** **10 B1+B2+B3+B4**
Ochratoxin A	Unprocessed cereals	**5**

Maximum levels for fusarium toxins (EU)

MYCOTOXIN	Product	maximum levels (ppb)
DON	Unprocessed cereals other than durum wheat, oats and maize	1 250
	Unprocessed durum wheat, oats	1 750
	Flour	750
ZEARALENONE	Unprocessed cereals other than maize	100
	Flour	75
FUMONISINS Sum of B1 and B2	Unprocessed maize (except for wet milling)	4000

Sampling

Uniform distribution

Protein (%)

12	13	12	14
13	13	14	12
15	11	12	12
13	14	11	9
13	12	12	13

Protein avg. 12,5 %

Non-uniform distribution

Aflatoxine (ppb)

0	0	0	0
0	0	0	0
0	0	0	0
0	200	0	0
0	0	0	0

Aflatoxine avg. 10 ppb

Pesticide residues

- Monitoring of pesticide residues in EU on cereals revealed
  - in 2001 72% < DL 27% < MRL 1% > MRL
  - in 2005 79% < DL 20% < MRL 1% > MRL

- In these cases where results > MRL
  - mainly storage / post-harvest insecticides
  - limited amount of growth regulators (Chlormequat, Mepiquat)
  - limited amount of herbicides (Glyphosate)

Main storage insecticides : MRL's wheat

Active ingredient	EU	Codex MRL (ppm)	EU MRL (ppm)
Chlorpyriphos-methyl	In	10	3
Deltamethrin	In	2	2
Malathion	Out + Rsub	0.5	8
Dichlorvos	Out	5	0.01
Fenitrothion	Out	10	0.5
Pirimiphos methyl	In	7	5
Endosulfan	Out	-	0.05
Bifenthrin	Pending	0.5	0.5
Permethrin	Out	2	0.05
Cypermethrin	In	0.2	2
Pyrethrins	in	0.3	3

Thank You for Your attention

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