SORGHUM MALTING

INTRODUCTION, OBJECTIVES AND SCIENTIFIC PRINCIPLES

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WHAT IS MALTING

Limited germination of cereal grains in moist air under controlled conditions

Pneumatic Germination Box type Sorghum Maltings

WHY MALT SORGHUM – PRODUCTS

Sorghum Malt for home brewing

For brewing Opaque beer, Lager and Stout

For “brewing” Malt (Malta) type non-alcoholic beverages

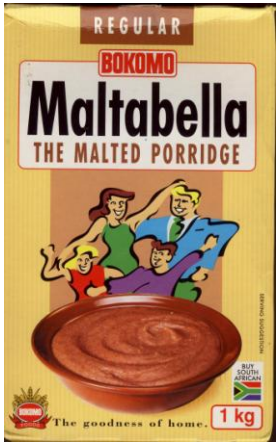
To produce Malt Extract for hot malted beverages, cereal and confectionery flavouring and colouring

For Breakfast Cereals

For “Power Flour” – enzyme active flour to “thin” infant porridges

Nigerian sorghum lagers, stout, malta and hot malt drink

Opaque beer



Sorghum malt breakfast cereal

Sorghum malt

Cola flavoured malta

WHY MALT – THE SCIENTIFIC REASONS

• To produce *Hydrolytic enzymes* (Amylases, Proteases, Lipases, Cell wall degrading enzymes, Phytase etc)

By means of these enzymes to:
1.Modify the sorghum grain structure during Malting
- So that the grain is more easily solubilised during the brewing process

By means of these enzymes to:
2. Produce *Simple Sugars* and *Amino Acids (FAN)* during Brewing
- The Yeast requires these for fermentation into Alcohol and Carbon dioxide

WHY MALT – THE SCIENTIFIC REASONS (CONTINUED)

3. By means of the these enzymes to:
Produce *Sugars* and *Amino acids* during Malting

- Sugars give malt its sweet taste

- When malt is dried at high temperature (*Kilned*) chemical reactions take place involving sugars and amino acids (*Maillard Browning* and *Caramelization*) to give malt its attractive brown colour and malty flavour

WHAT ARE ENZYMES

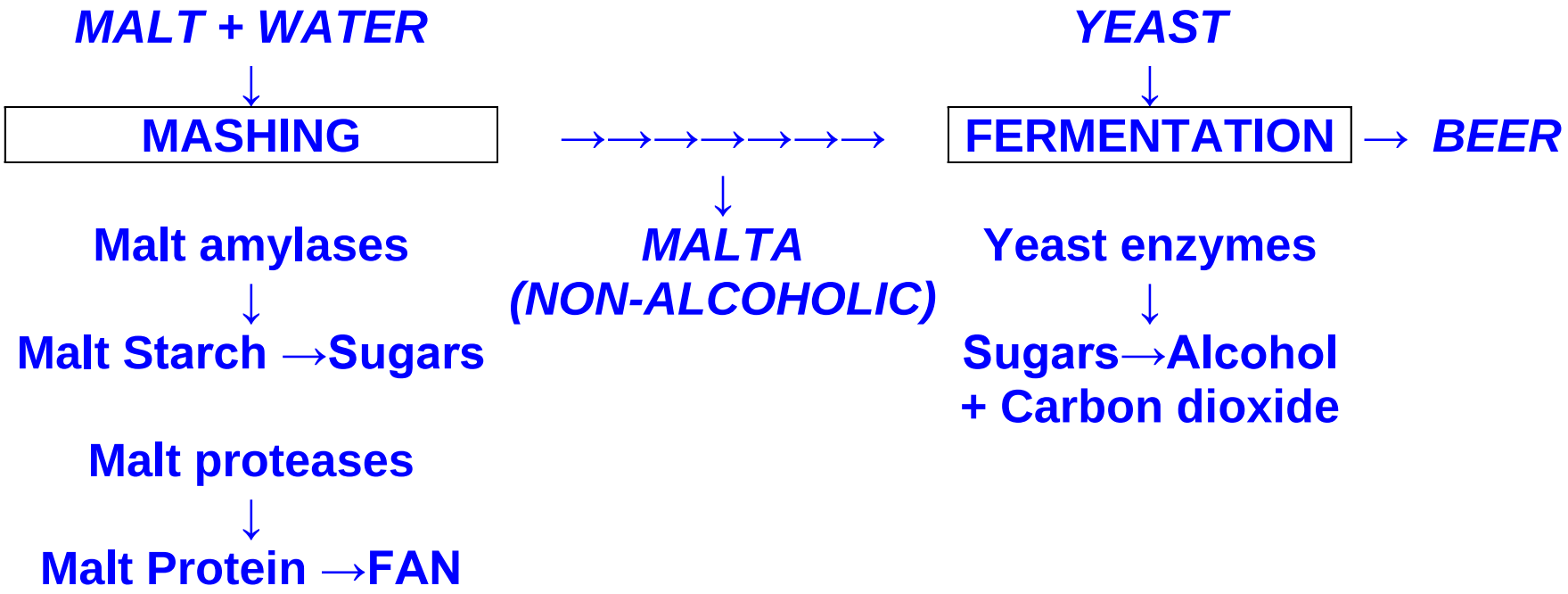
They are protein-based catalysts that carry out all the metabolic processes of living organisms

By far the important malt enzymes are:

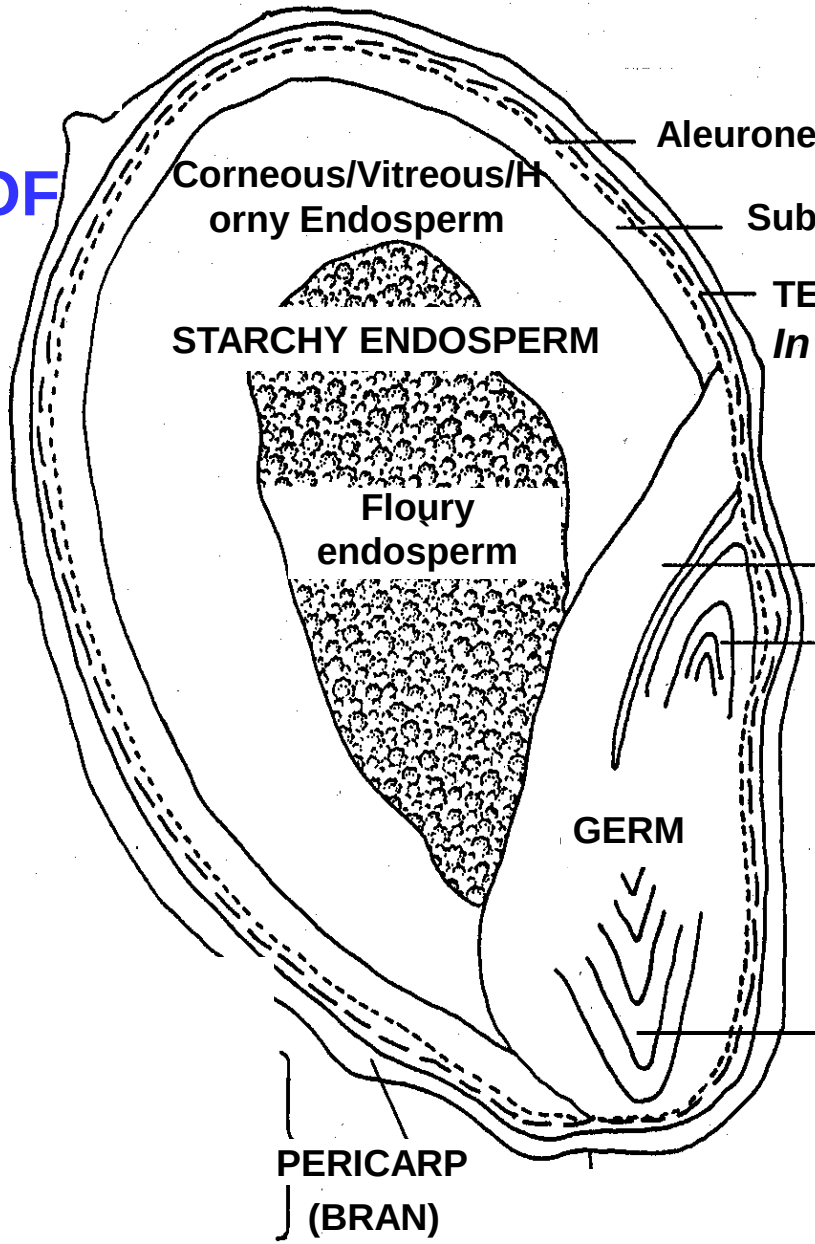
Amylases - Break down starch into its component simple sugars

Proteases – Break down proteins into their component amino acids – In brewing the these are referred to as Free Amino Acids (FAN)

SIMPLIFIED MALTA AND BEER BREWING PROCESS USING MALT



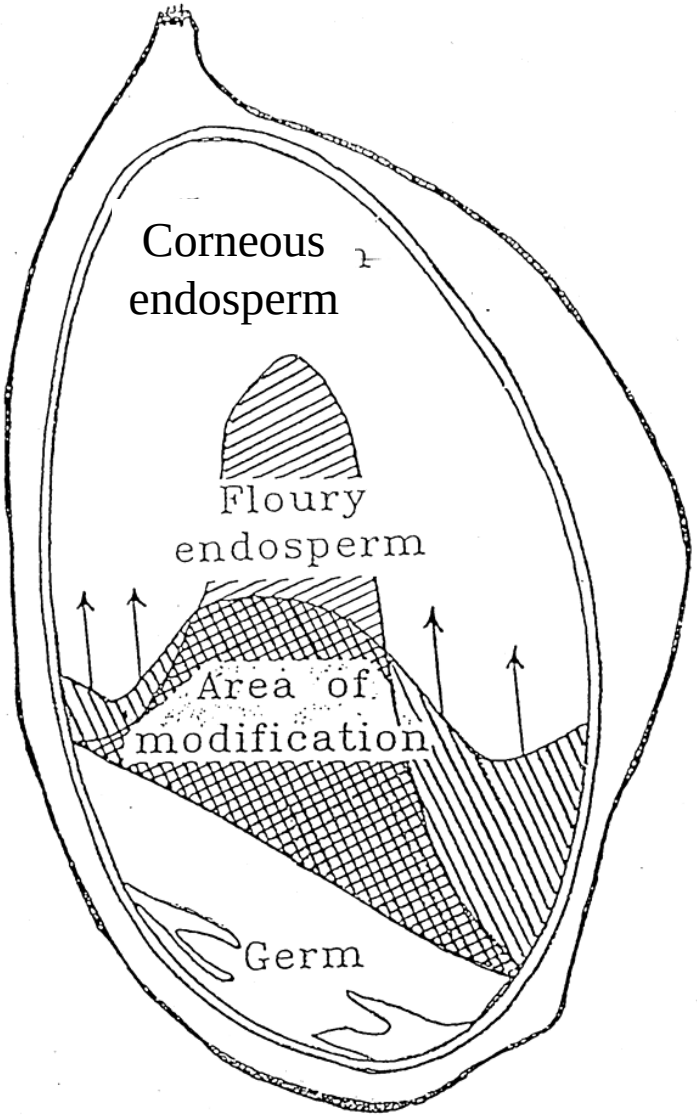
STRUCTURE AND COMPOSITION OF THE SORGHUM GRAIN



STARCHY ENDOSPERM
– Source of starch
for brewing

BRAN - rich in fibre
– in many sorghum varieties it is pigmented red`

SORGHUM GRAIN STRUCTURE MODIFICATION DURING MALTING



During Germination Enzymes migrate from the Germ and partially Break Down the Endosperm Starch Granules and Protein Bodies and Matrix – An area of Modification can be seen

NB In Sorghum - Cell Wall break down seems to be Negligible – This is different from what happens in barley malting

STARCH MODIFICATION DURING GERMINATION

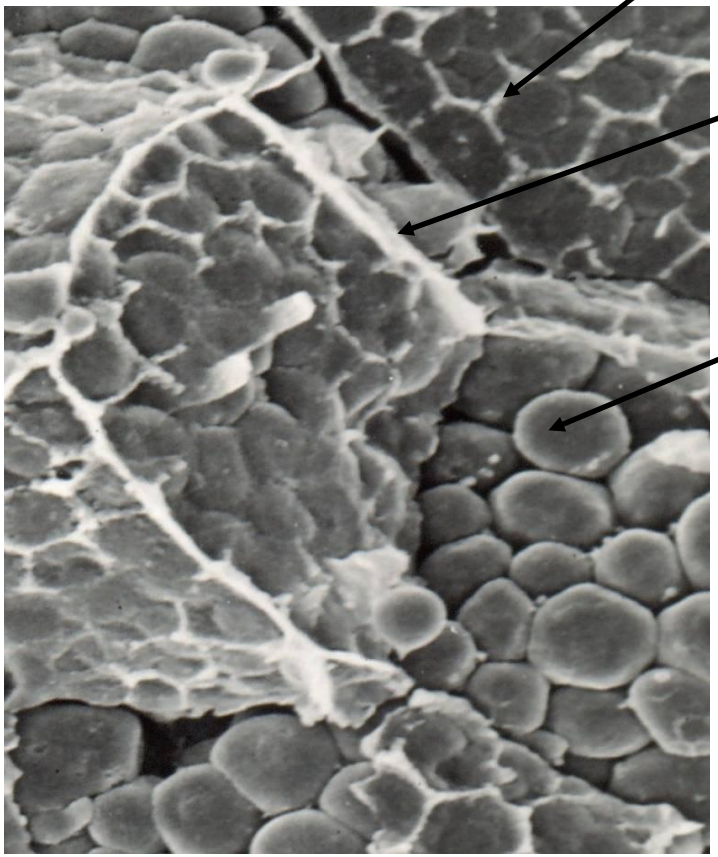
(As seen by Scanning Electron Microscopy)

Protein matrix

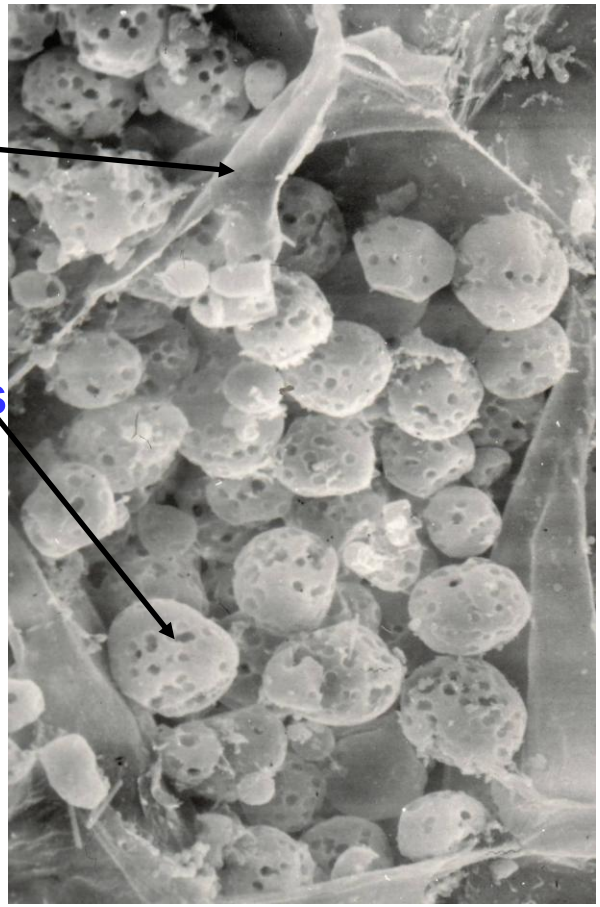
Cell walls

(NB Cell walls Intact in malt)

Starch granules



Grain cells

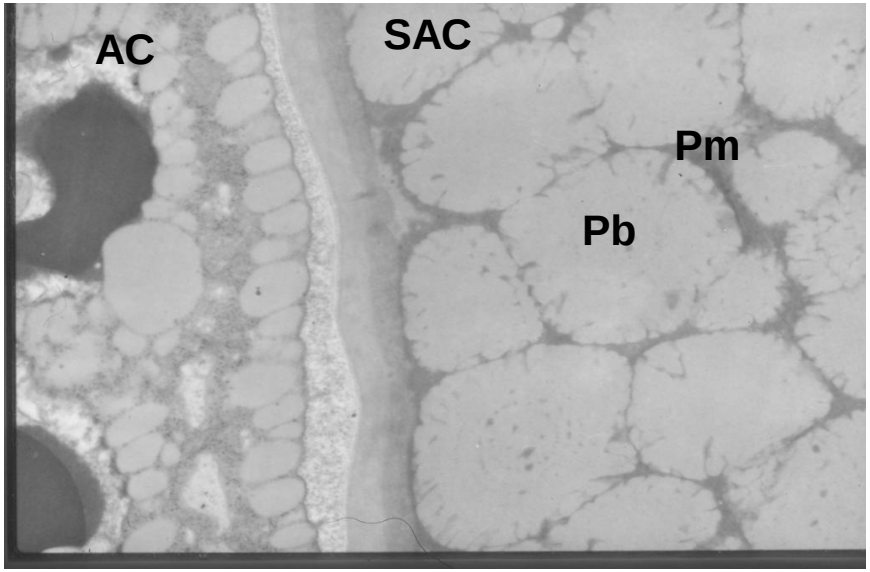


Malt cell

NB In malt - starch granules are full of holes Where amylase has broken them down

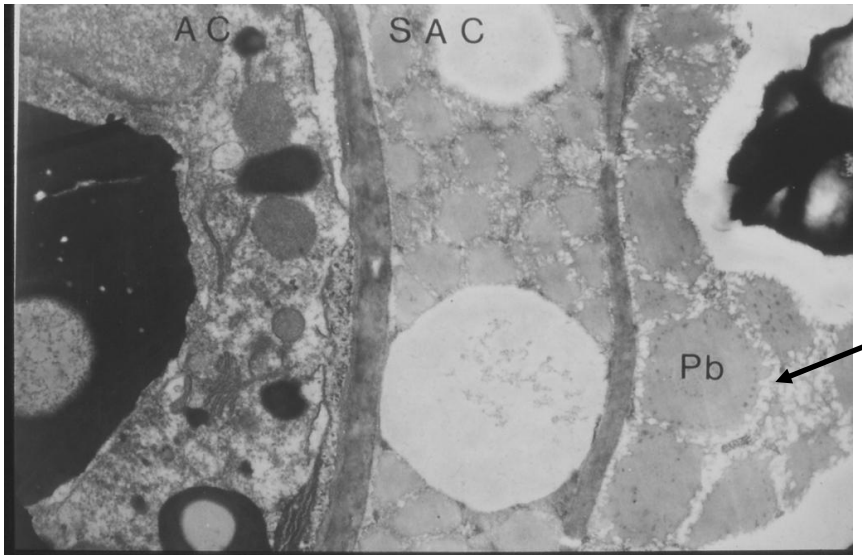
PROTEIN MODIFICATION DURING GERMINATION

(As seen by Transmission Electron Microscopy)`



Grain

AC = part of Aleurone Cell
SAC = part of Sub-Aleurone Cell
Pb = Protein body
Pm = Protein matrix



Malt

In Malt – Protein bodies and Protein matrix degraded away at edges, Where proteases have broken them down

STARCH HYDROLYSIS BY AMYLASES

Starch – polymer of 100s of glucose sugar units

-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-

There are millions of starch molecules in every starch granule

and
Millions of granules in every sorghum grain

and
Millions of sorghum grains in every brew

The are two major type of amylases in sorghum malt:

1. Alpha-amylase chops the starch molecule at random

-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-G-

-G-G-G-G-G -G-G-G -G-G-G-G-G-G-G

-G-G-G-G-G-G-G-G-G-

These short chains of glucose units are called Dextrins

2. Beta-amylase chops up the dextrins into Maltose (2 glucose units)

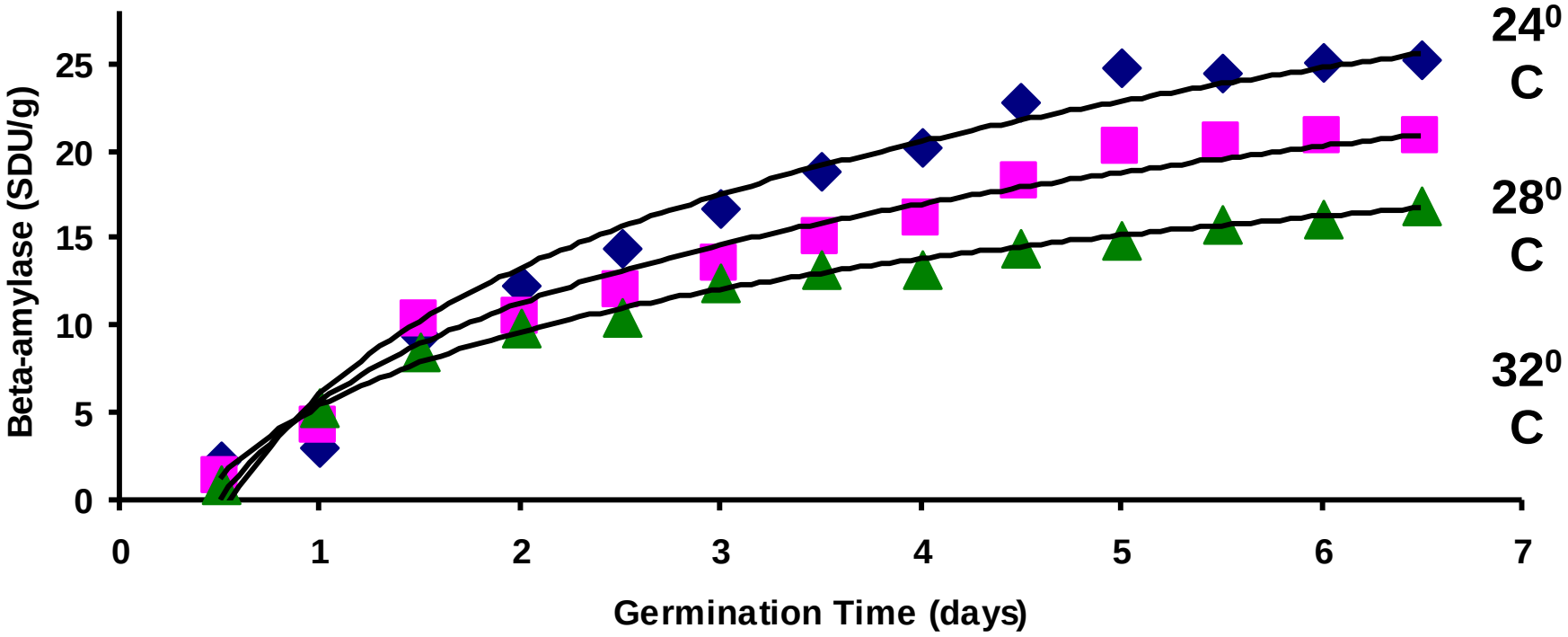
-G-G-G-G-G -G-G-G -G-G-G-G-G-G-G
-G-G-G-G-G-G-G-G-G-

-G-G -G-G -G -G-G -G -G-G -G-G -G-G -G
-G-G -G-G -G-G- G-G -G-

N.B. There is much less beta-amylase in sorghum malt than in barley malt

The joint activity of the alpha- and beta-amylase enzymes is referred to as Diastatic Power (DP)

DEVELOPMENT OF AMYLASE ACTIVITY DURING SORGHUM MALTING



There is essential no amylase activity in unmalted sorghum grain.

Activity develops during germination and is affected by germination Temperature and Moisture – This shows beta-amylase activity but Alpha-amylase is similar

PROTEIN HYDROLYSIS BY PROTEASES

Proteins – polymers of 50+ amino acid units

-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-

There are many millions of protein molecules in each sorghum grain

Proteins are broken down by two main types of protease

1. Endoproteases – Chop at random to produce peptides (short chains of amino acids)

2. Exopeptidases – Chop up peptides to produce FAN

Sorghum malt is rich in FAN

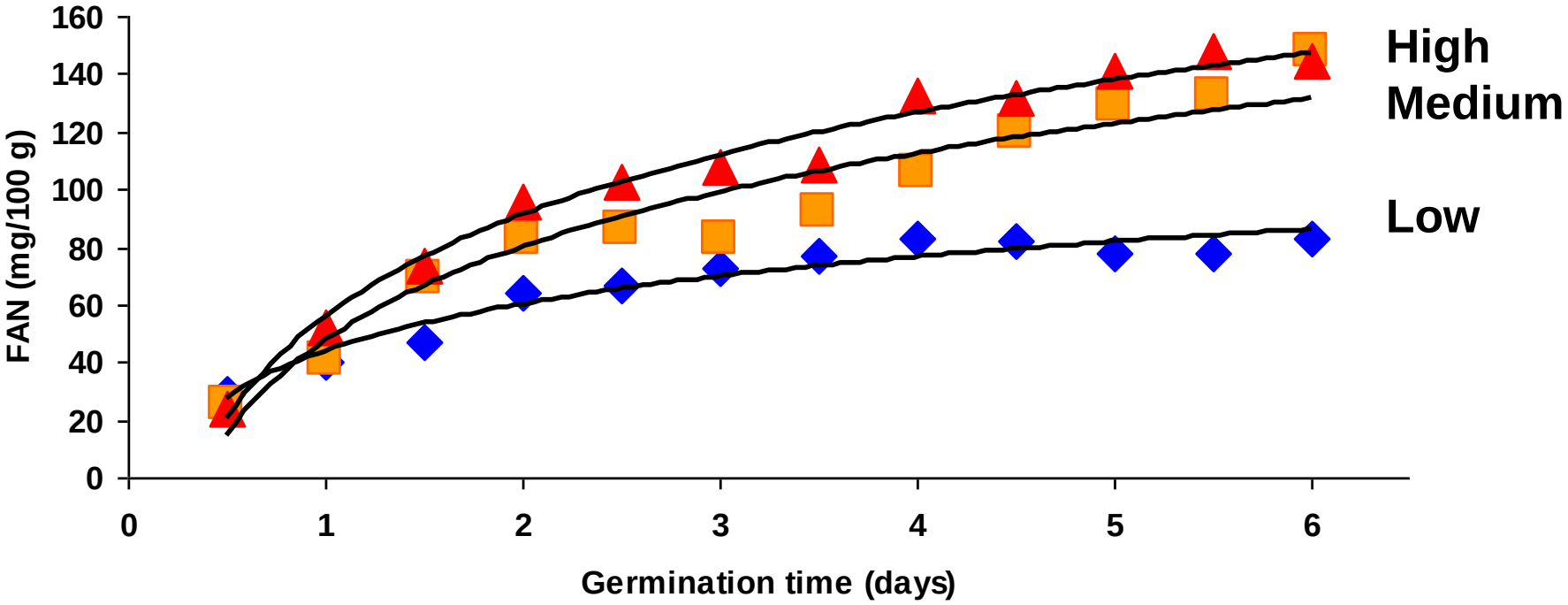
– Particularly the external roots and shoots

However

FAN production during brewing, unlike starch hydrolysis, is very slow

- Major sorghum proteins are resistant to break down

DEVELOPMENT OF FREE AMINO NITROGEN DURING SORGHUM MALTING

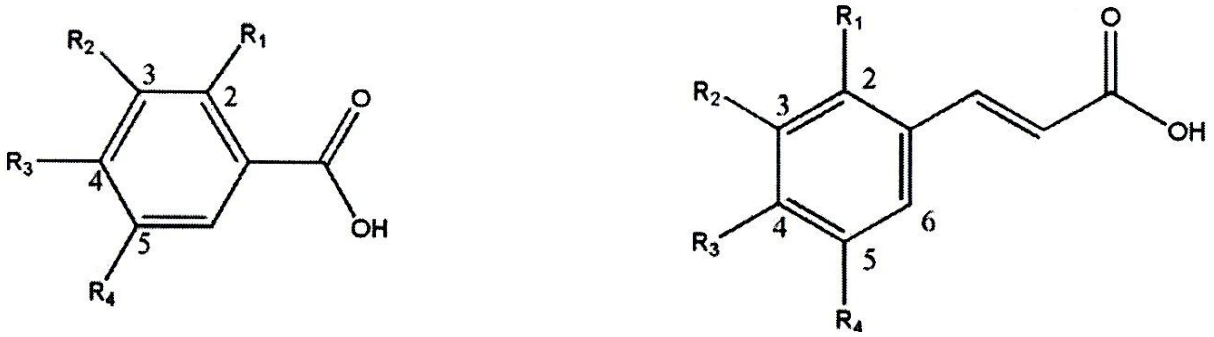


There is very little FAN in unmalted sorghum grain
FAN is produced as a result of protease activity
FAN production is affected by Germination Temperature and Moisture – This shows effect of Moisture
Optimum temperature is around 24^0C, as for amylase activity

PHENOLICS IN SORGHUM

Three different types of phenolics can be found in sorghum

1. Phenolic acids – simple chemicals found in all varieties of sorghums (in fact in all cereals)

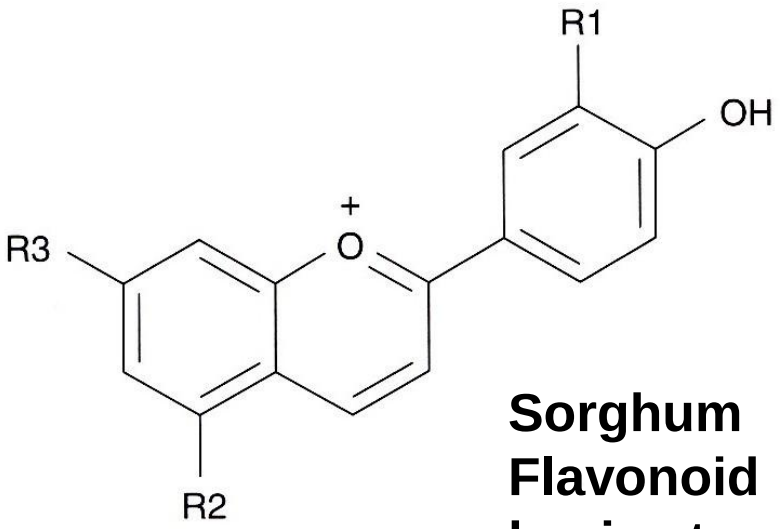


Sorghum phenolic acids basic structures

2. Flavonoids

More complex chemicals

- **Found in all types of sorghum, but concentration differs between varieties**
- **Flavonoids are pigments – so Red Sorghums contain much higher levels**
- **Concentrated in the Pericarp (bran layer)**

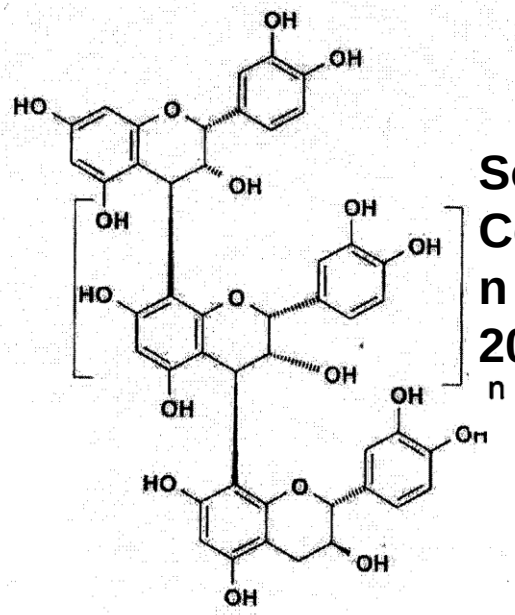


Sorghum Flavonoid basic structure

3. Condensed Tannins (Proanthocyanidins)

Complex polymers of flavonoid units

- ***Only found in Tannin Sorghums*** **(those with a Pigmented Testa layer)**
- **Colour of sorghum grain is a very poor guide as to whether it contains tannins**
- **N.B. Most Red varieties Do Not (as in previous slide)**
- **Some White varieties to do (as here)**



Sorghum
Condensed tannin
n = up to approx.
20 units of flavonoids

N.B. Tannins in malts made from Tannin Sorghums will inactivate malt enzymes when in brewing,
Unless tannins are inactivated

Treatments to Inactivate tannins during malting:

- Steep grain in very dilute formaldehyde solution (formaldehyde is a hazardous chemical. Its use in foods is not allowed in many countries

- Steep grain in dilute Sodium Hydroxide (Caustic Soda) Solution (preferred treatment)

Caustic steep of White Tannin Sorghum
Note: red phenolics extracted into Steep water

MOULDS AND MYCOTOXINS

The warm and damp conditions of sorghum malting encourage Mould (Fungal) growth

Some moulds can produce Mycotoxins (literally meaning "Fungal Toxins")

Examples of Mycotoxins include:

- **Aflatoxins - produced by Aspergillus fungi**
- **Fumonisins - produced by Fusarium fungi)**

Mycotoxins are extremely poisonous

They are Acute Poisons
and
Will cause Cancer with repeated exposure

Countries have very strict limits on Mycotoxins in Foods

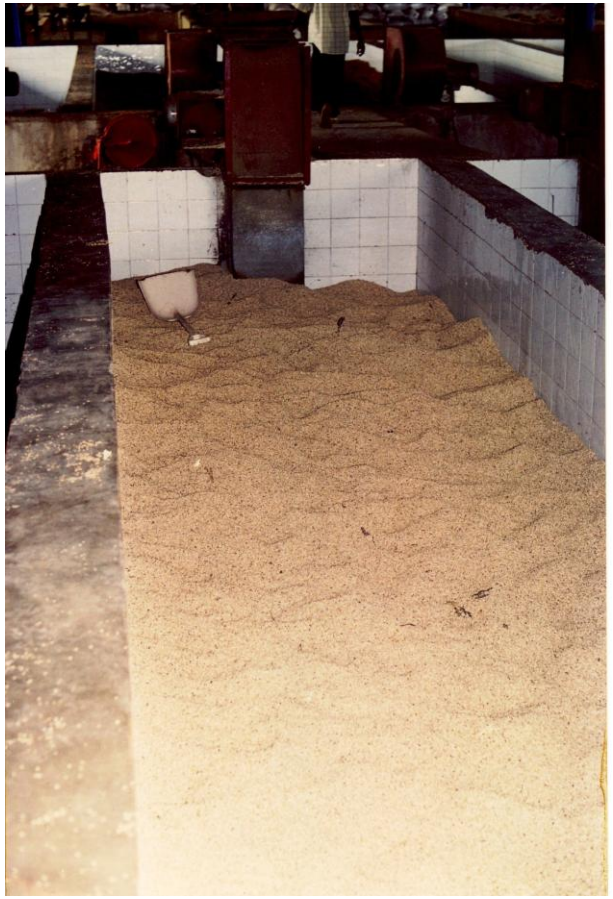
South African Regulations
10 micrograms Aflatoxin per kg (10 parts per billion)
i.e. 10 milligrams per ton of sorghum malt

Would you eat this malt?

I understand that the company involved brewed beer with it

PREVENTING MOULD GROWTH IN MALTING

1. Don’t use mouldy grain
2. Clean grain properly – remove all broken grains
3. Only use grain that has high germinability (>90%)
4. Caustic steep- reduces fungal load on grain
5. Keep germination time as short as possible
6. Don’t stress the germinating grain (malt on previous slide got too dry and died, and then was watered)
7. Make sure that the Turners prevent the germinating grain from clumping
8. Make sure that the Turners are not crushing the sorghum grains
9. Steam clean the malting boxes after each malting



A

B

Which of these two sorghum maltings will produce The better quality malt?