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From Beer to Bread Malt Cereals in Bakery Applications

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The scope of this talk is to give an overview of malt and malted ingredients including the basic principles of the process and some guidelines on bakery applications.

I have used the relationship to brewing partly to add a point of interest but mainly because the history of malt is so inextricably linked to that of brewing.

MALT

Malt is essentially any cereal grain that has been modified by controlled germination. The principle aim of the maltster is to break down the grain cell structure, generate enzymes and produce quantities of soluble material for further processing.

This material or extract is that part of the modified grain that will dissolve when ground and mixed with warm water in a brewing process known as mashing.

When you're talking malt, a maltster will normally presume that you're talking barley, with any other cereals such as wheat, rye and oats looked upon as specialities but in a world context a range of other cereals are also used including sorghum, millet and maize.

Theoretically, any seed or grain capable of germination is maltable but the reality is usually constrained by the size and shape of the material and the physical design of the malting process.

Food and Drink

The history of malting seems to run parallel with that of fermentation and brewing with references to both going back around 6000 years. The distinction between malt for food use or brewing is historically difficult to define as alcoholic brews were and still are in some regions of the world a staple source of nutritional intake.

There appears to have been a tacit understanding that both processes unlocked and enhanced nutritional content and improved the palatability of cereals.

This understanding developed to the extent that malted cereals came to be perceived as health foods due to their easy

digestibility and during the 19C a number of malt based products were marketed. Two of the more durable brands created during this period were Horlicks and Grape Nuts, one

of the more memorable though was a fortified wine called Maltine containing a mixture of alcohol, malt extract and cocaine!

The introduction of roller milling in the late 1800's opened the way for the use of hard imported wheats in bread grists and the functionality of high amylase malts found an application as one of the first flour improvers.

There are also references, although unfortunately little detail, to malted wheat grains being used as bread inclusions going back several hundred years.

However, it is indisputable that the major use for malt is in the production of alcoholic beverages and even within our own maltings, only around 12% of total production ends up as a food ingredient.

Because brewing has always been the primary market for malt, scientific knowledge has historically been dominated by this application. Fortunately, in terms of functionality, both industries use malt for very similar purposes. Current investigation into the bakery

applications of malt is therefore very much about the cross over and interpretation of this knowledge into the baking domain.

Today there are few malt types that do not serve equal function in both the bakery and the brewery and just to give a quick visual on how these products cross over...

Here we have a range of bakery and brewed products using similar malt types. In both applications, it is malt that defines the essential characteristics of the finished product.

Before I go into detail on this, a quick look at the malting process.

Aswith most biochemical processes, malting relies essentially on the control of time, temperature and moisture and the characteristics of the raw material. As already mentioned, in volume terms this is usually barley. Incidentally, barley is the cereal of choice mainly because of its husk which not only protects the growing shoot or acrospire during the early stages of germination but also acts as a filter during further processing stages.

A more interesting reason than this however is that Edward II in 1315 apparently decreed that beer should be made from grain other than wheat as so much of this was being used for brewing that there was a serious risk of the population starving to death.

The raw material is sourced to

precise specifications and, with barley in particular, varieties are selected according to the quality characteristics required in the finished malt. Intake tests are carried out to ensure that at least 98% of the load is capable of germination.

When calculating cereal requirements the factor ofmalting losses has to be considered. Dry weight losses that occur as a result of malting effectively means that 1 tonne of barley will only produce around 800 kg of malt. This comes from a combination of screenings, the loss of the rootlets which are removed after kilning and losses through grain respiration.

The grain moisture is standardised to 12%, passed through a cleaning process and then, from harvest, provided with a period of storage to allow the natural dormancy in the grain to diminish.

This schematic taken from one of our own maltings gives an idea of the complexities of what is essentially a wetting process.

This effectively kick-starts the grain metabolism and begins the conversion from grain to malt in a process that takes two days and results in 'chitted' malt with a moisture content of around 43

Traditionally malt was germinated on floors and manually handled, the aim being to prevent the rootlets from matting together and to

maintain the optimum temperature and humidity to sustain germination. Although some floor malting is still carried out the majority of malt is now produced in high volume automated processes. It is during germination that the malt begins to 'modify', a term that describes the breakdown of the internal structure of the grain and the acceleration of

biochemical processes particularly the generation of hydrolytic enzymes.

Although labour intensive and more difficult to control, the old style of floor malting in conjunction with traditional barley varieties still has some

marketing appeal for a number of specialist brewers.

Once the malt has reached the correct degree of modification germination is halted by kilning. This process uses control of temperature initially to reduce moisture to a level where the malt is made dormant but still enzyme active. Depending on the malt characteristics required, more elevated temperatures can then be used to further convert the malt and begin to develop colour and flavour through Maillard reactions.

So, essentially at this stage, the maltster can play with various time and temperature regimes to achieve a variety of intermediate product characteristics.

Further processing then presents us with a number of finished product types. From the kiln there are two processing options. By grinding and then mixing with hot water, the resulting liquid or 'wort' can be concentrated through evaporation to produce malt extracts and syrups; the former being produced exclusively from malt and the latter from the use of other cereal adjuncts. These can also be spray or band dried to produce powdered equivalents.

Amongst the family of malt ingredients, extracts are distinctive because of their high relative sweetness and mellow flavours.

Alternatively, the malt can be further processed in its dry state to produce flours and textural ingredients by a variety of different methods which we'll

come on to.

So far as bakery applications are concerned probably the most important distinction to make is whether a malt is enzyme active or not.

The major use for high amylase malts is in the distilleries for the generation of fermentable sugars for grain whisky production, but there are also some long established

applications in baked products. In the UK , the majority of these malts are produced from barley and a lesser quantity from wheat and other cereals.

As a general rule, because of the inverse relationship between enzyme activity and colour and flavour development, these malts in themselves tend to be low in both colour and flavour.

The benefits of enzyme functionality in the baking process are well known, from the early use of amylase and protease to the more recent use of xylanase

All of this functionality is present in cereal malts although it has to be acknowledged that, currently, this enzyme activity is not as specific in its effect as that available in synthesised enzymes.

Having said that, there are a number of techniques that can be used to optimise specific enzyme functionality and this is an area of research that we are currently investigating. First we need to look at how enzyme activity is measured. Because of the dominance of brewing and distilling in the

malting industry it is understandable that most of the analysis and associated terminology is brewing related. Historically a number of methods have been used to measure the enzyme activity of malts particularly with regard to amylase. Two of the more durable are DP (diastatic power) and DU (dextrinizing units) but there is some justification from a point of consistency for switching to the Ceralpha method as used in the milling industry.

In the following two classic examples for the use of high DP malts in the bakery, I've given values both in DP and Ceralpha units.

Left:150 DP (230 CU/g) Malt at 0.3% to flour weight against control

This slide gives a practical indication of the effect of a high DP malt used to promote volume and crust colour against a control. Both loaves were made to a 'no time' dough recipe utilising a datem/fungal amylase based conditioner.

Maillard reactions. Increasing temperatures will then continue to caramelise the malt further and by halting the process at specific times and temperatures, the malt can be 'fixed' to a particular degree of colour and an associated intensity of flavour. This process requires the use of a special vessel, the roasting drum, and provides us with the most intense colours and flavours both in extract and dry form.

In any food application where there is a requirement for flavour or colour impact, these products along with some of the higher kilned, non diastatic malts can provide the means. Examples of crystal malt use are shown here, again to provide an appropriate strength of flavour and colour to baked products including bread, cakes and biscuits to applications in confectionery and ice cream.

At the highest levels of colour, the roast malts provide the typical flavour characteristics found in rye breads and crackers as well as applications in savoury pies and other meat products. Again these malts are used either as dry flours, liquid extracts, or via more novel means of application.

As I've mentioned there is a link between colour and flavour and the following slide helps to demonstrate this.

Again we're back to brewing. The brewers' interest in malt colour, whether diastatic, non diastatic, crystal or roast, is obviously dependent on the final colour requirement of the beer and this is measured on the

wort or the liquid extracted from the malt during mashing. The colour test applied is a laboratory version of this mashing process which involves grinding the malt, mixing with water under controlled temperatures, filtering and then applying a visual comparison with a series of colour reference slides.

The rising colours are a direct result of increasing time and temperature in the kilning or roasting process. The colour comparison is measured in EBC units (European Brewing Convention) as shown in the vertical axis of the slide.

On the horizontal I've given a view of relative sweetness along with some subjective indication of flavour. The trough at the lower end of the scale is a symptom of the difficulties in achieving maximum conversion whilst keeping a grip on colour development. Otherwise I hope the chart is self explanatory with sweet, mellow flavours giving way to more robust flavours culminating in astringent, highly roasted flavours at the top end.

During the processing of malt into malted ingredients, a range of techniques can be used to further influence the suitability of products to end applications.

This includes:

Modification of texture to produce either crisp flakes and kibbles for use in cereal bars and biscuits or softer eating products for breads and cakes.

Modification of flavour by introducing other flavouring ingredients into the process.

The use of different milling techniques to produce malt flour extractions.

Given the relationship between colour and flavour, the latter is particularly useful for producing low coloured flours from high coloured, full flavoured malts for use in white breads.

We've looked at individual malted ingredients but there are major opportunities in product design by combining these ingredients to provide different flavour, textural and functional characteristics in compound form.

It is also important to stress that there are definite flavour synergies between malt and other food flavours in the bakery where an overtly malt flavour is not required but increased depth of flavour or flavour 'twists' are sought. Some successful examples of this are blends of certain malt types with products such as chocolate, caramelised milk, spices, dried sourdough and other food acids.

Levels of use are impossible to define as it depends on end product requirements, but as a rough guide, particulates are usually incorporated at between 10% to 20% with base

flavours using flours or extracts provided at around 1 to 5%. Caution is only really necessary when experimenting with high diastatic malts for obvious reasons.

As a general rule with non diastatic malts, levels of use would usually diminish as colour values increase.

Malt, in its various guises, already plays a major role in bakery formulations. So far as Edme is concerned there are three directions of opportunity for further developing the scope of this ingredient in bakery applications.

Firstly, to continue to explore the possibilities of different grain types and varieties in conjunction with the plant breeders including new developments in huskless or naked grain varieties.

Secondly, to apply these products to different food processes in order to further modify texture and flavour.

And thirdly, ongoing investigation into the enzyme and nutritional functionality of different malts should also offer some interesting opportunities for the future.

Question: David Roberts

The flavour of malt is a delight, one of the most popular sandwich breads. Am I right is saying in terms of functionality of the diastatic activity to some extent when we are looking at things like gas retention etc it tends to be overtaken by some of the more recent developments in cereal and fungal alfa amylase. Is that a fair statement?

Answer: - Yes that's true. There are, no matter what happens with cereal malts going to be limitations, especially with regard to alpha amylase because of the resistance to temperature but having said that there are a number of options by playing around with different cereal varieties and malting regimes.