A Scientific Approach to the Development of Sandwich Bread

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The application of scientific methodology can be used to help ingredient companies to develop new products, or improve the performance of existing products to meet the current needs of manufacturers and consumers.

New product development is often confronted with the challenge of setting targets and benchmarks for product attributes demanded by the market. The necessity of measuring those properties requires a deeper interface between the new product development process and various technical-scientific areas. In these cases, science becomes important for the implementation of methodologies, which have to be relevant, rapid and robust for the interpretation of results.

Within this report, an overview will be given on the important aspects of sandwich bread, why development work was conducted and how scientific methodology was developed to technically assess the performance of additives and a number of previously unused raw materials.

Introduction

There are three main groups of sandwiches, which are: -

Chilled sandwiches – including bread, rolls, subs, baguettes, wraps etc.

Hot sandwiches – including those filled with burgers and related products.

Warm sandwiches – reheated chilled sandwiches e.g. calzone type cheese melts and rolls.

Research has shown that the number of chilled sandwich outlets in the US has overtaken the warm sandwich outlets, showing the importance of this sector of the quick service restaurant market.

Chilled sandwiches are an important part of the UK take-away market and provide particular challenges to both bakers and sandwich producers.

There are a number of different types of sandwiches within the sector, which include standard, low fat, healthy eating and premium. These broadly follow the main food trends, one of the major trends is towards the increased quantity of fillings and this trend has a significant impact on the quality of the sandwiches. As the increased filling forces pressure on the bread slice, this can lead to compaction and increased moisture migration from the filling leading to soggy bread.

Quality requirements

The quality attributes for sandwich bread include the need for correct size and shape to fit the packaging, crumb colour and brightness for visual appearance and softness/staling rate and crumb resilience for eating quality. A number of these areas can be addressed through the close co-operation of the dough conditioner supplier, flour supplier and the bakery, whereas the effects on softness and crumb resilience require a more scientific evaluation.

The main areas discussed in this report revolve around crumb softness and resiliency.

Development work

This work has been conducted on chilled sandwiches. The sandwich supply chain begins with the bread being produced and delivered to the sandwich manufacturer at ambient temperature; the sandwiches are manufactured in a cold environment and then stored and distributed chilled, at approximately $4^{o}C$ prior to being sold chilled.

There are two main areas for this investigation. The first is the development of methods to assess ingredients and how they can be used to influence staling rate/softness and secondly to assess crumb resilience/moisture migration. The optimum temperature for the staling of bread is 4^oC, which is why we are told from an early age not to store bread in the fridge, however sandwiches are always stored in this way to ensure there is no risk of food poisoning from the filling.

The result is that bread can be hard, dry and crumbly or very soft and soggy depending on the filling. The typical shelf life of a sandwich is three to four days and if this could be extended to four to five days, this would be of considerable benefit to the manufacturers in terms of economy of scale and the demands of the customer.

The second area of investigation is crumb resiliency of the bread slices as they are compressed under the pressure of the filling or being forced into the packets. This is a particular problem as one of the trends is towards deeper filled sandwiches, which leads to greater compaction of the bread. This results in the bread becoming soggy due to moisture migration from the filling. If the slice was more resilient it could help to improve the overall quality.

The softness can be improved but this adversely affects the resiliency of the bread. The softer the slice, the less resilient the slice becomes and more liable to compaction.

Crumb Softness (Staling)

The first part of the investigation was to monitor bread staling over four days from production, in storage conditions that reproduce the thermal history of the product. To achieve this the bread was baked, stored at ambient for 24 hours and then chilled for the remainder of its shelf life. The bread arrives for processing between 8 and 24 hours old. Twenty-four hours was chosen as the maximum time at ambient temperature. The bread was then tested for softness with the Stable Micro Systems TA TX2 texture analyser using a method developed by Nic Franciosi, a member of the technical team. The bread was then stored at 4^oC and retested on a daily basis. The initial test was to assess the traditional crumb softening materials of oil, glycerol monostearate (GMS) and anti staling crumb softening bakery enzymes. The control is a loaf that contains no additional crumb softeners and is based on flour, salt, yeast, water and improver.

The addition of oil produces a firmer loaf on refrigerated storage than the control, which originally was thought to be an obvious way of softening bread. The GMS works well and better than the anti-staling enzyme. Having developed a method to assess the softness of sandwich bread through the supply chain further work can then be conducted to produce the optimum softening system. Combinations of GMS and different anti-staling enzymes were assessed and the results recorded.

The overall results from this series of tests show that combinations of GMS and/or anti-staling enzymes can produce any degree of bread softness but there comes a point at which the bread is too soft and lacks any resilience. Development work then needs to be conducted in improving the crumb resilience.

Crumb Resilience

In addition to the bread softness, parallel work has also been conducted on moisture migration in microwave products and studies were carried out on the use of hydrocolloids and associated ingredients in bread and related products. The reason to look at gel forming hydrocolloids is that there are reported benefits in improving bread resilience; improvements in tolerance to water diffusion and in their ability to bind water. These are some of the major requirements for good sandwich bread. Ingredients assessed included carboxy methyl cellulose (cmc), guar gums, sodium alginates and calcium acetates.

The reason to examine these ingredients is related to the manufacture of sandwiches in respect to the following areas. The slices of bread pass underneath a depositor, this deposits the butter onto the slice. However in malted grain breads, this can be problematic as the grains block the depositing nozzles, resulting in streaks of unbuttered bread. Coupled with the move to deeper fillings, which in turn come into closer contact with the bread and then compression of the sandwich when it is inserted into the packaging can cause soggy bread. This is through the migration of water from the filling to the bread particularly if the preventative moisture layer of the butter is not intact.

Relaxation Test

The effect of hydrocolloids and other bread ingredients on bread resiliency was measured by a relaxation test. This is a testing mode of Stable Micro Systems TA TX2 texture analyser. The bread is compressed with a certain force and the degree of deformation is showed on Y-axis over time. More importantly in the second part of the graph, the load-cell releases the pressure and monitors how quickly and at what extent the bread recovers from the deformation. This is done through a sensing force of 4.9g (0.049N).

The degree of deformation over 30 seconds to a certain level of force. The recovery is measured for 30 seconds, which appears to be a suitable timescale. This graph shows the effect of the crumb softener on recovery compared to a control with no softeners present. The addition of the softener reduces the resiliency of the bread, ideally the slice should recover as much as possible i.e. return to 0 degree of deformation. Following a series of tests, a combination of softening agents, plus other ingredients can give a soft slice that recovers well when compressed either by machine or by hand as the sandwich is prepared

Summary

The development of scientific methodology firstly to measure crumb softness and secondly crumb resilience has enabled the assessment of previously untried raw materials in a scientific manner. The results are obtained through objective measurement based on scientific principles and measurement with attention to detail and understanding the manufacturing process. As with all scientific methods, the results may challenge traditionally held beliefs.

In the experiments examining softness, it would have been expected that the inclusion of oil, GMS and anti staling enzymes would have all had beneficial effects. The results showed that GMS was the most effective agent and the softness could be enhanced with the addition of anti staling enzymes. The addition of oil had a negative effect on the softness as the proportion of solid fat increases at lower temperatures and in particular under refrigeration.

In the experiments examining resilience, the addition of previously untried ingredients has led to a technical break through in improving the overall quality of the sandwich by enabling the maximum softness to be achieved without producing bread that is too soft to process. The grades, particle size and viscosity properties of these ingredients also play a vital part. The ingredients supplier can provide the detailed understanding and analysis of these ingredients.