facts

How to make better batters

Improve indulgency and healthiness of your battered products

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Introduction

As different trends in convenience foods come and go, the food industry is tasked with keeping up with the consumer. The modern consumer demands a product that is both high in nutritional value and carries an indulgent, premium image. On the other side, industry and the production chain have had several challenges to manage these demands. This paper addresses challenges in batter applications like improving pick-up, reducing surface cracks and creating a homogenous batter. Several Jungbunzlauer products, xanthan gum, sub4salt® and glucono-delta-lactone, can improve your batter's performance:

Xanthan gum is designed to improve the sensory parameters of battered products like juiciness and texture. By reducing fat uptake of a batter system, xanthan gum is also able to improve nutritional values.

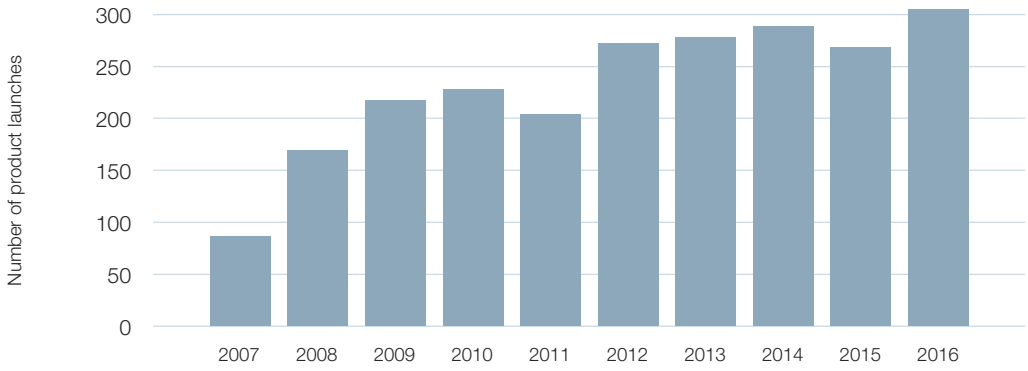
With the use of the salt replacer sub4salt®, a sodium reduction of up to 35% can be achieved while maintaining the same taste and functionality of the battered product.

Finally, glucono-delta-lactone can be applied as slow reactive acid to replace phosphates.

Why is improvement in batters needed?

Over the last ten years the number of battered product launches in the market has consistently increased (figure 1). In 2016 alone, the market saw over 300 new battered products, which demonstrates this is a market that requires innovation.

Figure 1: Number of battered products launched within 2007-2016 (Innova Market Insights), Total number of launches: 2300



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In the last decade a clear trend towards healthier food has emerged in battered products. Producers are looking for alternatives to improve the nutritional value of their products in order to fulfill the demand for premium indulgent products which are healthy for the consumer. A common and easy way to improve the nutritional value is to increase the protein content and reduce the fat content in battered products. Market data shows that within the last 10 years 9% of the new launched products had high in protein claims and 6% low fat claims. The third strongest trend is sodium reduction. 4% of the battered products contained salt replacers. Additionally there was a smaller number of product launches claimed as high in fiber or low in cholesterol.

How does the batter process work?

The application of batter to the substrate is one step in a complex coating system. The following will explain the functionality of coating and batter processes, followed by the standardised lab set up used for all trials.

Introduction of coating systems

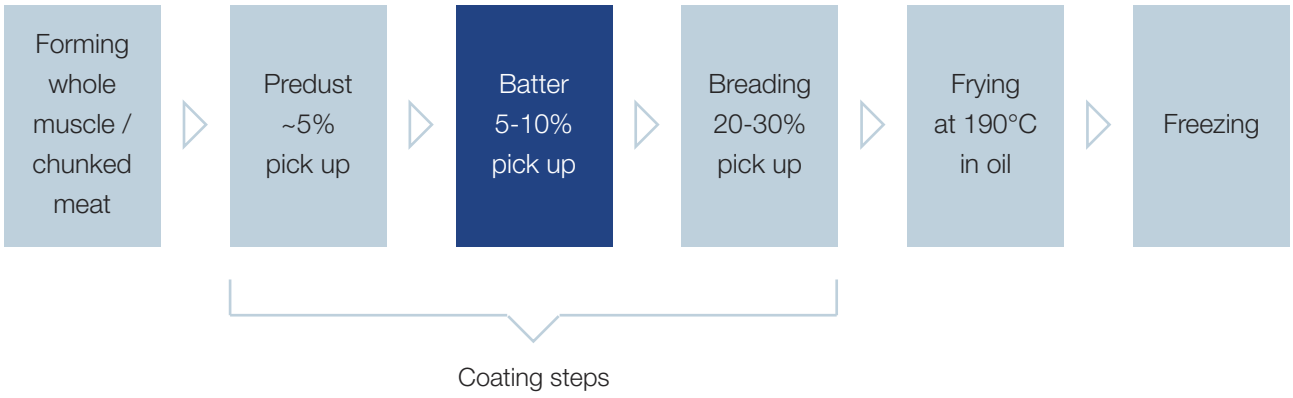
Coating systems are used in deep-fat frying to enhance flavor and improve the appearance of fried pieces by reducing dehydration, supporting browning and giving texture to the end product. Additionally, the coating systems help to protect the finished product e.g. during freezing storage. The most important reason for applying a coating system is the yield improvement of the product.

During a coating process different layers are sequentially applied onto the surface of a product. These layers can be a liquid, particulate based, or be a combination of both.

The following diagram describes the coating process for chicken nuggets. The formed muscle meat is predusted followed by the application of batter and breading (figure 2).

The advantage of applying layers is that each layer builds an interface between the substrate and subsequent coating stage, leading to a better adhesion and pick-up.

Figure 2: Single steps of chicken nugget production



Introduction of batter systems

The batter builds the intermediate layer between the predust and the breading in the coating process (figure 2). Batters are liquid doughs consisting of water, flours, proteins, gums, leavening agents and seasoning. They are applied by an overhead flow onto the meat or by dipping the meat into the dough prior to frying. Two different categories of batters are distinguished: adhesion batters and cohesion batters.

Adhesion batters are starch based with a high solid content and low viscosity. They are applied as a thin coat between the substrate and breading layer. The ratio of solids to water used in adhesion batters ranges from 1:1.4 to 1:1.9.

Cohesion batters are flour based containing a lower amount of solids than adhesion batters; they are more viscous than adhesion batters and are designed to form a shell around the product. The common ratio of solids to water used in cohesion batter ranges from 1:1.5 to 1:2.

The focus was laid on improving tempura batters, which are cohesion batters. Tempura batters are based on flour/starch mixtures. They contain leavening agents which create a puffed layer around the substrate after frying. The advantage of using such batters is that they serve as an outer coating and no breading is needed to supplement them. The common ratio of solids to water used range from 1:1 to 1:1.3.

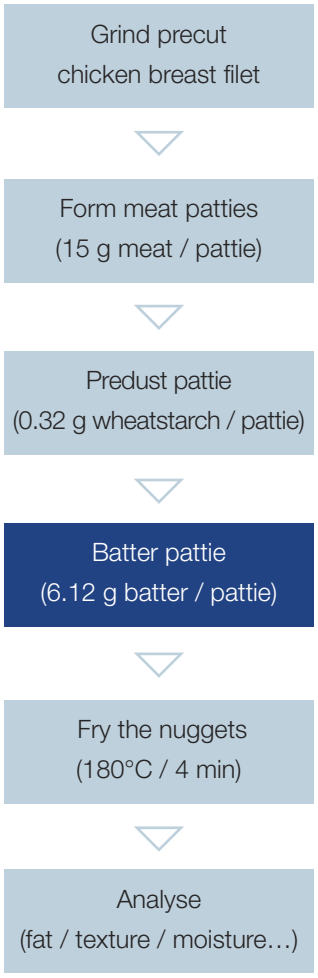
Description of lab test set up

The goal of the trials was to improve nutritional composition as well as the sensory and processing parameters of the tempura. The batter was applied to ground chicken meat as a test matrix. During the standard production process the chicken filet was first ground and formed into meat patties of 15 g each (figure 3). Afterwards the patties were predusted with wheat starch (5% of the end products weight) followed by application of the tempura batter (25% of the end products weight). The standard tempura batter was prepared by mixing one part dry batter with one part water, no xanthan gum was added. Two additional batters were prepared containing 0.5% and 1% xanthan gum. For these the dry batter was diluted in water in the ratio 1:1.3.

To apply the comparable amount of batter to the chicken nuggets the amount of water had to be decreased in the batter without xanthan gum.

After battering, the samples were packaged and stored at -40°C (-40 degrees Fahrenheit) for one day. Then they were fried at 180°C (356 degrees Fahrenheit) for four minutes in sunflower oil.

Figure 3: Lab trial set up for chicken nuggets



How can batters be improved?

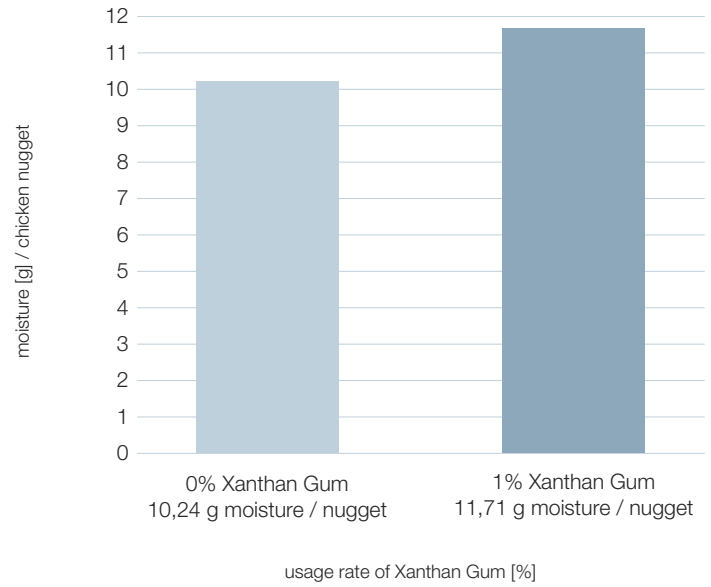
As presented earlier in the market data, the consistent improvement of battered products is in the food industry's spotlight. The following explores different possibilities for improvements in batters, with sensory, processing and nutritional parameters as the key focuses.

Improvement of the sensory parameters of tempura batters

Moisture improvement with Xanthan Gum

Hydrocolloids in combination with water build a protective film around a substrate, which prevents moisture migration from the substrate to the outside during frying. To evaluate the water loss difference between the batter with and without xanthan gum, the moisture content of the fried chicken nuggets was measured before and after drying in the oven at 104°C (219 degrees Fahrenheit) for 24 h (oven model Memmert). The results showed that chicken nuggets which were coated with a batter containing xanthan gum lost significantly less moisture compared to nuggets which were coated with the standard batters. This result is in accordance with result of previous studies (Izadi et al. 2015[5]; Singthong and Thongkaew 2009[10]; Garcia et al. 2002[4]).

Figure 4: Moisture content in chicken nuggets (n=5)

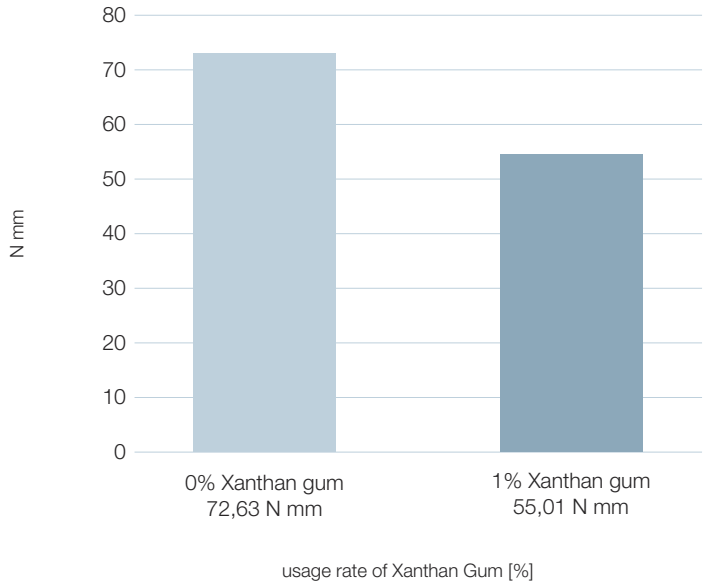


Texture improvement with Xanthan Gum

Texture has a large impact on the end products' taste and mouthfeel. The influence on chewiness after the addition of xanthan gum was measured.

Chewiness is defined as the energy which is required to chew a solid food product to a state where it is ready for swallowing. Our results show that chicken nuggets with xanthan gum are easier to swallow and less gummy compared to the standard. The chewiness of the nuggets was measured with a LFRA texture analyzer (LFRA 4500, Brookfield, USA). For the standard chicken nuggets a chewiness of 72.63 N mm was measured. When adding 1% of xanthan gum the chewiness was significantly reduced to 55.01 N mm.

Figure 5: Chewiness of chicken nuggets (n=5)



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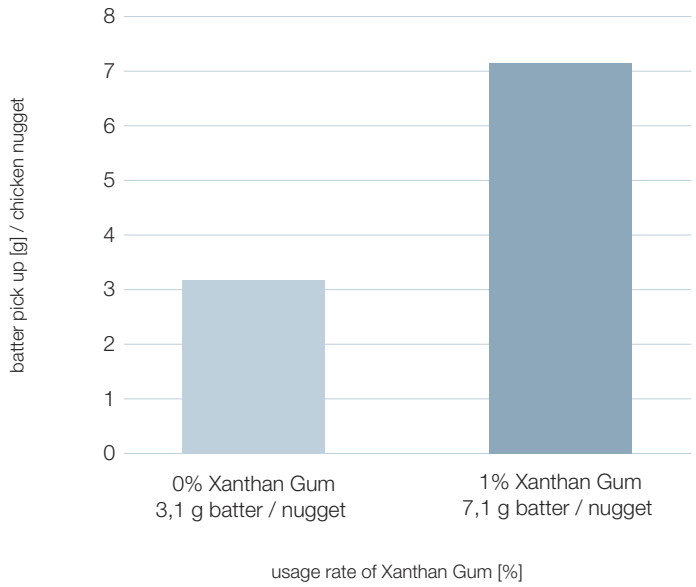
Improvement of the processing parameters of tempura batters

Pick-up improvement with Xanthan Gum

The use of hydrocolloids in batter systems increases viscosity of coating systems and reduces run-off during processing, helping to control the amount of batter that adheres to the product (Sarteshnizi 2015[11]). The trials showed that the addition of 1% xanthan gum to the dry batter mix can significantly increase batter pick up to 56%. The pick-up was measured by weighing the nuggets directly after battering them.

Figure 6: Batter pick up at chicken nuggets (n=10)



Stability improvement with Xanthan Gum

The application of xanthan gum to the batter mix improves the stability of the batter. Already a small amount of 0.5% xanthan gum kept the solids stable in the liquid phase of the batter mix.

Additionally, adding xanthan gum to the batter led to a more even surface after the chicken nuggets were fried and less cracks occurred on the surface during frying (figure 7).

Figure 7: Chicken nuggets after frying: left without Xanthan Gum, right with Xanthan Gum

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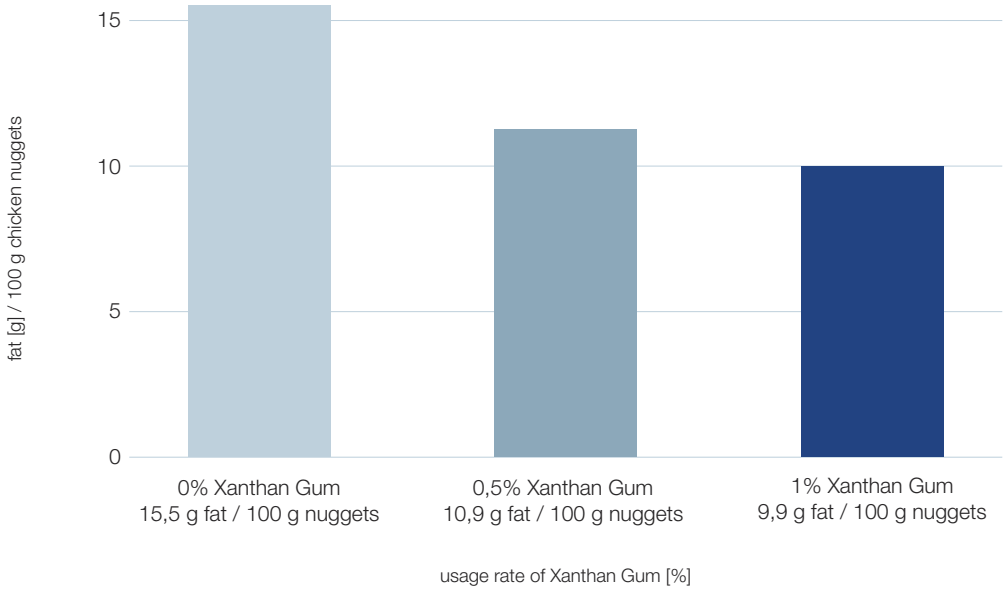
Improvement of the nutritional composition of tempura batters

Fat reduction with Xanthan Gum

Fried foods can contain up to one third fat (Mellema 2003[6]). Consumers want lower fat products and data shows that more and more battered products with the claim “low fat” are entering the market. An effective way to minimise the oil absorption during deep-fat frying is to add xanthan gum in low concentration (0.5-1%) to the coating system (Varela and Fiszman 2011[12]). The hydrocolloids build a protective film around the substrate which acts as barrier against oil absorption during frying (Albert and Mittal 2002[1]; Duxbury 1989[3]). During the trials it was shown that the addition of xanthan gum to the batter reduced the fat uptake of the chicken nugget significantly. To measure the fat content of the nuggets the Soxhlet extraction with petroleum ether was used.

After frying, a fat content of 15.5 g fat/100 g was measured. This is a representative average value for chicken nuggets. After the addition of 0.5% of xanthan gum to the batter dry blend, a fat reduction of 29.7% was achieved. When doubling the xanthan gum amount to 1% in the batter dry blend an even higher fat reduction of 36.13% was achieved (figure 8).

Figure 8: Fat content in chicken nuggets (n=10)



The addition of xanthan gum can significantly reduce the fat content of the nuggets. As shown earlier (see: improvement of the sensory parameters of tempura batters) the lower fat chicken nuggets also had a better chewiness and a higher moisture content compared to the standard chicken nuggets.

Sodium reduction with sub4salt®

Battered products have a high sodium content, between 600 mg and 1180 mg sodium per 100 g (Yogesh et al. 2013[13]). This corresponds to 1.5% to 3% salt per 100 g. The WHO recommends a salt intake of 5 g per day. Studies show that a diet high in salt raises blood pressure and increases the risk of heart disease and stroke. Food developers are looking for strategies to reduce the sodium content in batters. Many governments follow the sodium guidelines of the WHO and have set up sodium targets for their country. If producers do not follow the targets they may have to face consequences like a warning label at the front of the packaging. Figure 9 gives an overview on the permitted maximum sodium levels in different countries.

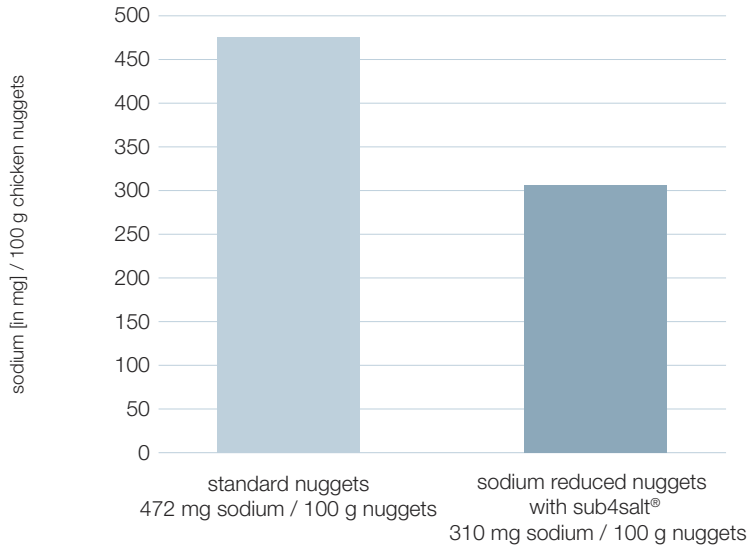
Figure 9: Regulation on maximum sodium levels in battered products

Country / Food category	Deadline	Sodium limits in mg per 100 g
United Kingdom / reformed meat	2017	540
United States / battered chicken	n.a.	420
Chile / all food	2019	400
Israel / all food	2020	400
South Africa / processed meat	2019	650

But how can the industry reach these governmental targets? Sodium reduction in chicken nuggets is quite challenging as salt is used in poultry products to enhance the products flavor (Rabe et al. 2003[7]). On the other hand salt has a large effect on the texture of foods (Desmond 2006[2]; Saint-Eve et al. 2009[9]). To achieve a sodium reduction without compromises in taste or functionality, salt was replaced with the salt replacer sub4salt®. sub4salt® is an optimised mineral salt blend of sodium and potassium salt as well as sodium gluconate. Its superior taste like standard salt is achieved by the masking properties of sodium gluconate which covers the off-notes of the potassium salt.

At a 1:1 replacement of salt with sub4salt® a 35% sodium reduction was achieved while taste and texture was maintained. A large advantage of the usage of sub4salt® is that it is very easy to handle because no adjustments of the standard recipe are needed.

Figure 10: Sodium reduction with salt replacer sub4salt®



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Phosphate replacement

The production of gas in batters, also called leavening or rising, plays a major role in the product's texture and appearance. Non-yeast leavening systems produce the carbon dioxide that is necessary for the rising of the dough through the reaction of a carbon dioxide source, mainly sodium bicarbonate, with one or more leavening acids. Sodium acid pyrophosphate (SAAP) is the most common leavening acid. However, phosphates have recently begun to lose their appeal in food manufacturing due to concerns in modern health trends. Researchers have found that elevated phosphate concentrations in healthy people correlate with cardiovascular diseases and the authors recommend reducing and controlling the uptake from phosphate containing food additives (Ritz et al. 2012[8]).

A much healthier solution to sodium and phosphate containing SAPP is the leavening agent glucono-delta-lactone (GdL). GdL is the neutral cyclic ester of the organic acid gluconic acid and is formed by the removal of water. Gluconic acid naturally occurs in plants, fruits and other foodstuffs such as wine (up to 0.5%) and honey (up to 1%). Jungbunzlauer's gluconic acid and GdL are produced by microbial fermentation of a natural, renewable and non GMO containing carbohydrate source.

When added into an aqueous solution GdL dissolves rapidly into the medium, but hydrolyses gradually to gluconic acid, leading to a controlled decrease of pH while taste changes from slightly sweet to mildly acidic.

GdL and sodium bicarbonate do not react in the dry state, making the blend shelf stable. However, when water is added to their mix with the other dry ingredients of the batter, GdL and sodium bicarbonate quickly dissolve. Subsequently, GdL hydrolyses slowly to gluconic acid which then reacts with the sodium bicarbonate to release carbon dioxide. This especially an advantage when it is used in tempura batter to delay a premature reaction of the baking powder.

GdL is a permitted food additive and can be used after the quantum satis principle. It is nontoxic, completely metabolised in the body like a carbohydrate.

The chicken nuggets with GdL can be claimed as phosphate free.

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About Jungbunzlauer

Jungbunzlauer is one of the world's leading producers of biodegradable ingredients of natural origin. We enable our customers to manufacture healthier, safer, tastier and more sustainable products. Due to continuous investments, state-of-the-art manufacturing processes and comprehensive quality management, we are able to assure outstanding product quality. Our mission "From nature to ingredients®" commits us to the protection of people and their environment.

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