SPX®

Puff Pastry Based on Palm Oil

White Paper

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EXECUTIVE SUMMARY

Food companies today are like other manufacturing businesses not only focusing on the reliability and quality of the food processing equipment but also on various services which the supplier of the processing equipment can deliver. Apart from the efficient processing lines we deliver, we can be a partner from the initial idea or project stage to the final commissioning phase, not to forget the important after-market service. SPX Flow Technology has Gerstenberg Schröder installations in more than 110 countries around the world.

The objective of this paper is to describe the production of puff pastry margarine based on palm oil and additionally explain the interchangeability of fats and oils, including the importance of a flexible production line. Puff pastry margarine based on palm oil was compared to puff pastry margarine compounded of soybean oil in regard to possible differences in plasticity and baking performance. The influence of various processing parameters was additionally discussed.

INTRODUCTION TO SPX FLOW TECHNOLOGY

VISION AND COMMITMENT

SPX's Flow Technology segment designs, manufactures and markets process engineering and automation solutions to the dairy, food, beverage, marine, pharmaceutical and personal care industries through its global operations.

We are committed to helping our customers all over the world to improve the performance and profitability of their manufacturing plant and processes. We achieve this by offering a wide range of products and solutions from engineered components to design of complete process plants supported by world-leading applications and development expertise.

We continue to help our customers optimize the performance and profitability of their plant throughout its service life with support services tailored to their individual needs through a coordinated customer service and spare parts network.

CUSTOMER FOCUS

SPX Flow Technology develops, manufactures and installs modern, high efficient and reliable processing lines for the food industry. For the production of crystallized fat products like margarine, butter, spreads and shortenings SPX offers Gerstenberg Schröder solutions which also comprise process lines for emulsified food products such as mayonnaise, sauces and dressings.

FATS AND OILS IN GENERAL

Initially, the interchangeability of oils and fats will be described since special attention should be paid to the formulation of the fat blend when margarine is produced. Since margarine is characterized as a water-in-oil emulsion like butter, the functionality of the margarine depends to a large extend on the fat blend.

The ingredients used in the fat blend can derive from any animal, vegetable or marine oil source. The choice of fats will depend on legislation, economics, quality, functionality and on marketing constraints. The latter can limit the interchangeability of fats if 100% vegetable- or low trans fatty acid margarines are in market demand. In addition, the availability of fats can be limited due to legislation, religious prohibitions, or trade barriers.

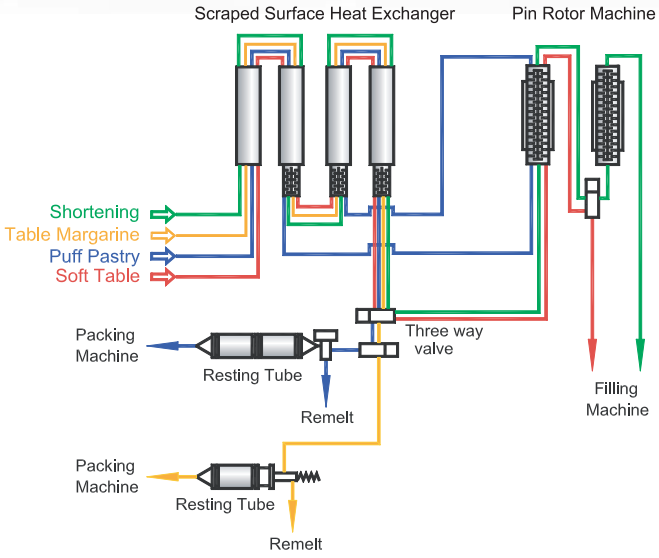
LIQUID OILS	SEMISOLID FATS	HARD STOCK
UNSATURATED VEGETABLE OILS	HYDROGENATED VEGETABLE OILS, MP: 32-34°C	PARTIALLY HYDROGENATED OILS AND FATS, MP > 40°C
PALM OLEIN	HYDROGENATED MARINE OILS, MP: 32-34°C	FULLY HYDROGENATED OILS AND FATS, MP > 40°C
PALM KERNEL	PALM	BEEF TALLOW
COCONUT	LARD	PALM STEARIN

Table 1: Composition of the fat blend

It is possible to divide ingredients into three main categories: liquid oils, semisolid fats, and hard stocks. A suitable blend can be made by combining one or more ingredients from each of the three groups. Liquid oils are today considered to be completely interchangeable as components of margarine and shortening blends due to the modern refining processes.

Fat-modification processes, such as fractionation, hydrogenation, and inter-esterification enable a high degree of interchangeability among fats. The modification processes produce, individually or in combination, the full range of fatty intermediates used in the manufacture of all types of margarines and these processes enable fats to become almost completely interchangeable.

However, certain technical limitations exist when combining one or more ingredients from the three groups. The crystallization habit, or polymorphism, of the used fat can set limits on the proportion of the particular fat used in the blend. In addition, the crystallization rate of the fat blend is of great importance in regard to the set up of the plant. In order for the product to be fully crystallized by the end of the processing line, the resting or holding time in the equipment is of great importance.



The flow diagram shows the flexible Gerstenberg Schröder crystallization line on which a full range of products can be produced by easy modifications of the plant. Apart from the processing flow, the formulation and the processing conditions such as capacity, intensity of chilling, RPM and volume of pin rotor machine and intermediate crystallisers have to be adjusted according to the specific type of product. Also as described above, a particular product specification can be met by a large number of alternative formulations, i.e. fat blends containing different raw materials. The flexibility is needed since the crystallization characteristics of the blends might differ from one blend to another. The producer attains the flexibility, in times of shortage or high cost, to interchange the best available and cheapest raw materials in an ever changing market situation. By the flexible GS scraped surface heat exchanger line not only the producer but also the consumers will be certain to produce and buy, respectively, a product with continuously the same quality and price.

GS pin rotor machine

PRODUCTION OF PUFF PASTRY MARGARINE

Puff pastry margarine has the features of exhibiting a very good plasticity without being oily. The plasticity of the finished margarine depends on the crystallization process, on the composition of the fat blend and on the processing conditions. In this paper, all of these issues will be discussed. As it can be noted from table 2, three different recipes have been used for the production of puff pastry margarine. In addition, various processing parameters have been applied and the influence of these will be discussed later.

Recipe 1 is based on palm oil and its fractions. It exhibits high amounts of palm stearin and furthermore, it has a low content of *trans* fatty acids since it contains only 15 parts of partially hydrogenated palm oil. Recipe 2 can be characterized as high in *trans* fatty acids since it contains only partially hydrogenated soybean oil intermediates apart from the liquid oil. Hydrogenated fats are known to exhibit plasticity, thus puff pastry margarine may contain a large amount of hydrogenated fats. Recipe 3 is like recipe 1 based on palm oil, but it exhibits a high content of partially hydrogenated palm oil, thus relatively high amounts of *trans* fatty acids. In the literature it is described that palm oil like hydrogenated fats applies plasticity to the products.

FATS AND OILS	RECIPE 1	RECIPE 2	RECIPE 3
PALM STEARIN	50 PARTS	-	10 PARTS
HYDROGENATED SOYBEAN OIL MP 45/46°C	-	25 PARTS	-
HYDROGENATED PALM OIL MP 41/42°C	15 PARTS	-	40 PARTS
HYDROGENATED SOYBEAN OIL MP 41/42°C	-	40 PARTS	-
HYDROGENATED PALM OIL MP 35/36°C	-	-	15 PARTS
HYDROGENATED SOYBEAN OIL MP 35/36°C	-	15 PARTS	-
RBD PALM OIL	15 PARTS	-	15 PARTS
LIQUID OIL	20 PARTS	20 PARTS	20 PARTS

Table 2: The formulations of puff pastry margarine

Partially hydrogenated fats may contain up to 55% *trans* fatty acids depending on the hydrogenation process. Several studies have indicated a correlation between a certain intake of these isomers and the risk of cardiovascular heart disease. Based on these studies, there seem to be a global trend towards a reduction of *trans* fatty acids in fat products to 5% or less. In this study recipe 1 contains less than 7% trans fatty acids where recipe 2 and recipe 3 may contain more than 25% *trans* fatty acids.

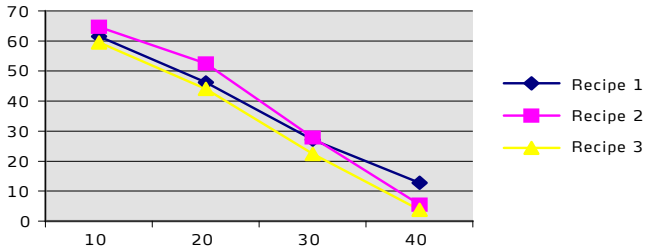
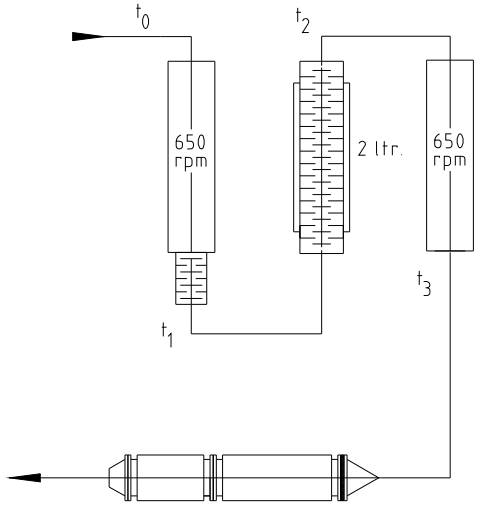


Figure 1: SFC profiles of the puff pastry margarine blends

The fats and oils were supplied by AarhusKarlshamn, Denmark, and the emulsifiers were supplied by Danisco A/S. As for the emulsifier, the water phase was the same for all three margarine blends.

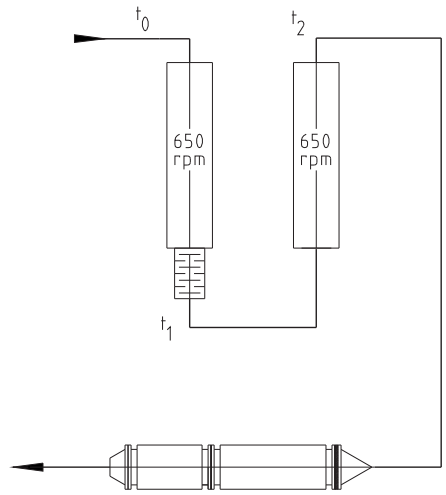
The above figure 1 shows the SFC profiles of the three different blends. It can be noted that the blends have very similar SFC profiles and only minor differences are noted such as the melting point for recipe 1 being slightly higher when compared to the other two blends. Therefore, based on the SFC profiles it could be expected that these three blends should be processed in similar ways.

The blends were processed by two different set-up of the Perfector pilot plant. Processing flow 1 where the pin rotor machine is positioned between the two cooling tubes in order to apply mechanical work to the product, and the intensity of 600 RPM or 300 RPM were applied.



Processing flow 1

For processing flow 2 the pin machine was left out. For both processing flows a capacity of 30 kg/h was used, the cooling by means of NH_3 was constant -20°C for the first cooling section and -15°C or -10°C for the second cooling section. The produced samples were matured at 28°C for 3 days.



Processing flow 2

EVALUATION

The produced puff pastry margarine samples were evaluated according to subjective and objective methods. The subjective evaluation included kneading test of plasticity, bending test, and test of greasiness. The baking test was the basis of the objective evaluation.

The subjective evaluation showed no major differences between the samples for each recipe. All samples had a good plasticity, but some of the samples were too soft and showed tendency to greasiness. However, when the products were compared, differences were observed between the three recipes. The samples of recipe 1 were evaluated as the best products since the samples were evaluated to be dry, firm and plastic. The samples of recipe 2 were all greasy and samples of recipe 3 showed tendency to greasiness. The subjective evaluation proposes that the maturing temperature was too high for recipe 2 and 3.

When producing puff pastry, basic dough is rolled out and the roll-in margarine, the puff pastry margarine, is placed on the dough in one flat piece and following completely covered with the dough. Several folding and rolling procedures follows in order to produce multiple alternate dough/margarine layers. These layers result in products with flaky structure. The flakiness depends on the formation of thin films of gluten which trap water vapor and carbon dioxide from fermentation. These laminates can form a three-dimensional structure and for this not to occur, the laminates must be separated by continuous sheets of fat. Thus, fat works as a barrier between the basic dough layers and prevents them from joining while they are being reduced in thickness during the folding and rolling procedure. In order to work as a barrier, the fat should not be absorbed by the dough layers, and it must remain as a continuous fat film throughout the rolling process.

The objective evaluation, the baking test, involved baking of puff pastry products consisting of 144 layer. In the below figure, recipe 1 showed the best results measured by baked volume, followed by recipe 3 and recipe 2. These results show the importance of not only the composition of the fat phase but also the processing parameters including the maturing temperature. Unfortunately the study did not include other maturing temperatures than 28°C, but one could discuss that better results for recipe 2 and recipe 3 might have been achieved by a lower maturing temperature.

GS Perfector for fat crystallization

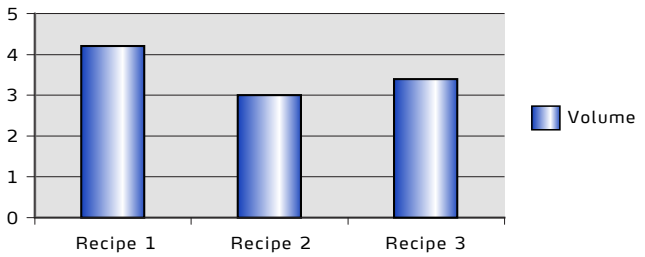


Figure 2: Baking performance measures in volume (cm^3/g)

CONCLUSION

The study showed that puff pastry margarine compounded of palm oil fractions results in products with better plasticity and baking properties. On the pilot plant scale the various processing parameters did not significantly influence the quality of the individual products. The residence time did not have a major influence on the quality of the products. For the specific fat blends in this study, the maturing temperature showed to be of great importance in regard to the consistency of the puff pastry margarine and do not seem to correlate with the SFC of the fat blend.

GS Perfector pilot plant

SPX®

ABOUT SPX

Based in Charlotte, North Carolina, SPX Corporation (NYSE: SPW) is a global Fortune 500 multi-industry manufacturing leader

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