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Hydrolysis of starch by sorghum malt for maltodextrin production

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Maltodextrin is a mixture of saccharides with a molecular weight between polysaccharides and oligosaccharides with DE lower than 20. Maltodextrin is more soluble in water than native starches, also is cheaper in comparison with other major edible hydrocolloids. Maltodextrin is obtained by moderate enzymatic or acidic hydrolysis of starch. The hydrolysis of starch, catalyzed by amylases, is the most important commercial enzyme process. The hydrolyzed products are widely applied in food, paper and textile industries. Because of the increasing demand for these enzymes in various industries, there is enormous interest in developing enzymes with better properties, such as raw starch-degrading amylases suitable for industrial applications and their cost-effective production techniques. Sorghum (*Sorghum bicolor*) is a widely grown crop in Africa. Obtaining enzymes from sorghum requires a transformation. The objective of this study was application of sorghum amylase for maltodextrin. Sorghum seeds were supplied by the ISRA (Bambey, Senegal). Seeds were germinated in the laboratory at 30°C for 72 h and the sorghum malt was dried at 40°C for 48 h. Corn starch (from Roquette, France) hydrolysis was assayed in a bioreactor of 2 l at a temperature of 65°C gently stirred. Raw starch was slurried in water (30% w/v) and sorghum malt was introduced, chloride calcium was added, pH was adjusted to 6. Maltodextrin was characterized in term of the dextrose equivalent (DE) during the hydrolysis. The yield of hydrolysis was evaluated by soluble solids (° BRIX) at different hydrolysis time. The glucose concentration released was measured by DNS method (Miller method).
Keywords. Sorghum amylase, enzymatic hydrolysis, maltodextrin, dextrose equivalent.

Study of the rheological behavior of chocolate and margarine

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In the food industry, the production process is often established in an empirical way, according to rules of good practice. These methods present gaps, in particular at the level of the production regularity. To model and optimize the processes, it is highly useful to determine the physico-chemical properties of the product. In this work, chocolate and margarine are studied, both aiming direct industrial application but also aiming a general enhancement of rheological mechanism understanding. Indeed, the chocolate is a suspension of solid particles in cocoa butter and the margarine is a water-in-oil emulsion. Rheological behavior of those fluids is therefore relying on different key phenomena. In this work the flow behavior of both products is characterized and a mathematical model describing the rheological behavior of chocolate is developed. For chocolate, the goal is to model the tempering process. To establish the rheological behavior of chocolate, viscosity measurements were realized

in a SEARLE VT550 viscometer using a bob and cup geometry. To build the mathematical law, general tests following the International Office of Cocoa, Chocolate and Sugar Confectionery (IOCCC) recommended method (Servais et al., 2004) were performed. The obtained rheogram shows that the chocolate has a slightly thixotropic behavior. More focus is set on a smaller range of shear rate important for the industrial application (Debaste et al., 2008). Measures for various temperatures and various quantities of cocoa butter were realized. The results show a classical shear-thinning behavior. Further, a statistical analysis of the results was made to determine the parameters of a power-law describing this behavior. It appears that temperature and cocoa butter fraction have no influence on the exponent but well on the consistency parameter. For margarine, the goal is to model the flow in resting tubes, the last step in the industrial production (Herman et al., 2008). To determine the rheological behavior of the margarine two kinds of devices were used. First the SEARLE VT550 viscometer with a four blades impeller was used. And the results were not satisfying because the measured viscosity was often nulls. We suppose that the sample was broken into two blocks, one between the blades of the impeller and a second outside of the impeller. A HAAK MARS rheometer with a plate-plate geometry was also used. In both experiments we evaluate how a change of 1°C can affect the viscosity of margarine. The obtained flow curves show that the margarine has a plastic and thixotropic behavior and that a variation of 1°C affects margarine's rheology. With the chocolate rheological law, the perspective is to get a general model for concentrated suspensions. And for margarine, more measures with an adapted viscometer should be done to build a model.

Keywords. Rheology, thixotropy, chocolate, margarine.

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Monitoring and robust adaptive control of fed-batch cultures of microorganisms exhibiting overflow metabolism

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Overflow metabolism characterizes cells strains that are likely to produce inhibiting by-products resulting from an excess of substrate feeding and a saturated respiratory capacity. The critical substrate level separating the two different metabolic pathways is generally not well defined. Monitoring of this kind of cultures, going from model identification to state estimation, is first discussed. Then, a review of control techniques which all aim at maximizing the cell productivity of fed-batch fermentations is presented. Two main adaptive control strategies, one using an estimation of the critical substrate level as set-point and another regulating the by-product concentration, are proposed. Finally, experimental investigations of an adaptive RST control scheme using the observer polynomial for the regulation of the ethanol concentration in *Saccharomyces cerevisiae* fed-batch cultures ranging from laboratory to industrial scales, are also presented.

Keywords. Bioreactor, control system and optimization, overflow, on-line fed-batch.