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A new, simple method for the production of meat-curing pigment under optimised conditions using response surface methodology

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ABSTRACT

The production of cured meat pigment using nitrite and ascorbate in acidic conditions was evaluated. HCl, ascorbate and nitrite concentrations were optimised at three levels using the response surface method (RSM). The effects of process variables on the nitrosoheme yield, the wavelength of maximum absorbance (λ_{max}), and L^*, a^* and b^* values were evaluated. The response surface equations indicate that variables exerted a significant effect on all dependent factors. The optimum combinations for the reaction were HCl = −0.8, ascorbate = 0.46 and nitrite = 1.00 as coded values for conversion of 1 mM hemin to nitrosoheme, by which a pigment yield of 100%, which was similar to the predicted value of 99.5%, was obtained. Likewise, the other parameters were not significantly different from predicted values as the λ_{max}, L^*, a^* and b^* values were 558 nm, 47.03, 45.17 and 17.20, respectively. The structure of the pigment was identified using FTIR and ESI/MS.

1. Introduction

Current meat-curing practice, which is founded upon the ancient art of preserving meat with salt, employs the addition of nitrite (and in certain products, nitrate) along with salt, sugar, reducing agents, and phosphates to meat (Rubin, Diosady, O'Boyle, Kassam, & Shahidi, 1992). Nitrite has beneficial effects on meat products and potentially detrimental effects on human health. The role of nitrite in cured meat is four-fold: i) it provides the characteristic pink-red cured-meat colour to the lean tissue; ii) it inhibits the growth of a number of bacteria that cause food poisoning or spoilage; iii) it contributes to the distinctive flavour of cured meats; and iv) it retards oxidative rancidity in processed meat products, principally through a process of metal chelation.

Despite these beneficial effects on cured-meat products, there were deep concerns about the use of nitrite and nitrate as food additives because both are potentially toxic for humans. The lethal oral doses for humans have been established in the range of 80–800 mg of nitrate and 33–250 mg of nitrite/kg body weight (Honikel, 2008). Over time, nitrite has been suspected of playing a role in the development of cancer, methemoglobinemia in infants, and even reproductive toxicities such as birth defects (Archer, 2002). Recently, epidemiological relationships were shown between cancer incidence and intake of processed meats (Demeyer, Honikel, & De Smet, 2008; Faramawi, Johnson, Fry, Sall, & Yi, 2007). The N-Nitrosamines in meat products, are compounds that could cause carcinogenicity. These compounds (e.g., N-nitrosopyrrolidine and N-nitrosodimethylamine) are formed, albeit in the parts-per-billion range, by the reaction of nitrite with the amines or amino acids that are present in foods. In addition, the existence of residual nitrite in cured meat increases the body's total nitrite load, which in turn may lead to an increased likelihood of nitrosamine formation within the human digestive tract (Rubin et al., 1992). However all health implications being associated with nitrite/nitrate consumption are tenuous and suggestive at present and no known case of human cancer has been shown to result from exposure to N-nitroso compound and all datas are according to indirect observations. It should be mentioned that inspite of concerns about consumption of cured meat products, recent studies demonstrate that nitrite have benefitial effects on health and upon its ingestion and mixture with gastric acid, is a potent bacteriostatic and/or bactericidal agent for gastrointestinal, oral, and skin pathogenic bacteria (Archer, 2002). The potential role in hypoxic vasodilation and protective action against ischemia are other physiological and pharmacological properties of nitrite that has been recently considered (Butler & Feelisch, 2008; Parthasarathy & Bryan, 2012) but due to the potential health hazard associated with the use of sodium nitrite, extensive studies have been conducted to find methods to reduce nitrite in cured meat products. The chance of finding a single compound which duplicates all functions of nitrite is very slight. Therefore, the development of a multifunctional system, including the synthetic cooked cured meat pigment have been considered (Shahidi, Rubin, Diosady, & Wood, 1985). Cured meat pigment is ordinarily developed by the reaction of nitrite with the natural meat pigment myoglobin to form dinitrosyl ferrochrome (DNFH). The pigment, which gives meat its characteristic cured-meat colour, is formed from the meat pigment

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