Shelf life of Goat Infant Formula Powder

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Abstract

Oxidative rancidity was found to be a problem in goat milk infant formula powder. Oxidative rancidity results from the lipid oxidation processes, where oxygen reacts with unsaturated fatty acids from milk powder to produce lipid hydroperoxides and radicals, the primary oxidation products. These primary oxidation products are odourless; however, they are very reactive to breakdown into hydrocarbons, aldehydes and ketones. Aldehydes have low flavour threshold limits and are responsible for causing the rancid flavour in the milk powder.

Peroxide value (PV) is one of the most widely used tests for oxidative rancidity as it is a measure of the concentration of lipid hydroperoxides; however, it is difficult to provide a specific guideline relating PV to rancidity. A reliable test is needed to determine whether the goat milk infant formula powder is unacceptable due to oxidative rancidity to the consumer. It was found that oxygen was a useful parameter to monitor lipid oxidation. Oxygen is the main reactant in lipid oxidation, and the rate of oxygen consumption is a useful tool to track lipid oxidation. Hexanal was determined to be the main secondary oxidation product responsible for the off flavour of milk powder.

An experiment of accelerated storage trials for two infant formula products (Powder A and Powder B) was conducted by using a range of higher temperatures from 37°C to 57°C over a period of 12 to 24 weeks. Headspace oxygen and headspace hexanal of the milk powder in the glass vials were measured over the storage period. Sensory analysis was also conducted in parallel with the storage trial to provide a relationship between the sensory score and hexanal concentration, ultimately determining the unacceptable flavour threshold limit for hexanal concentration. The chemical kinetic constants were estimated by fitting a general n^{th} order reaction with an Arrhenius law model with the concentration of oxygen obtained experimentally. The model followed half order reaction for both products. The Arrhenius rate constant, k_0, and activation energy, E, were found to be 7.8×10^{9} $\%^{0.5}$ $week^{-1}$ and 62.0 kJ mol^{-1} for Powder A and 1.34×10^{7} $\%^{0.5}$ $week^{-1}$ and 45.60 kJ mol^{-1} for Powder B.

It was discovered that oxygen and hexanal were highly correlated with R^2 of 0.905 for Powder A and R^2 of 0.918 for Powder B when fitted exponentially. It was predicted that Powder A would be unacceptable after a storage time of 40 weeks, and 31 weeks for Powder B under 25°C storage temperature.

Data tables were generated to outline the different maximum storage times allowed with different storage temperatures and different initial storage oxygen concentration.

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