The Effects of pH and Heat Treatment Processing on the Stability of Natural Food Colours used in Dairy Products.

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Abstract

This study was carried out to investigate the effects of pH and heat treatment processing on stability and natural food colours used in dairy products. A repeated laboratory experiment was conducted in which loss of colour intensity or change in shade of natural food colours used in acid and nearly neutral dairy products at low and at boiling temperatures was investigated. Five (5) natural food colours out of the fourteen (14) in the study were applied to small-scale industrial processing of UHT milk drinks and laboratory-scale yoghurt making. All the fourteen natural food colours studied were stable to pH changes. Only one natural food colour (Beet root) was destroyed at boiling temperatures while two of the colours (Beet root and Cochineal) were destroyed at UHT (136°C/ 4Seconds) processing. It was then concluded that pH changes and Heat Treatment processing do not contribute very much to the destruction of natural food colours used in dairy products.

Key words. pH, Heat, Stability, Food Colours.

Introduction

The addition of colouring substances to foods is an old practice. Many authors have advanced reasons for this practice, some of which, according to Drew and Lyons, (1998); Potter and Hotchkiss (1995) are:

a) To supplement and enhance natural and preferred colour of product destroyed during processing or storage.
b) To make it possible to manufacture a product of consistent colour from raw material of inherently variable colour.
c) To add attractive and acceptable colour to colourless products and
d) That colour influences or reflects food quality.

The negative and unacceptable use of food colours is the possible masking of deficiencies in ingredients thereby deceiving consumers of the quality of the products (Crosby, 1984; Hui, 1992).

Today, most consumers are sensitive to the nature of food additives and tend to prefer natural additives that are considered safe. Food processing companies would like to use natural food colours in their products so as to meet the desires of the consumers, but there are several factors which cause colour degradation during processing or storage and these include; light, oxidation and reduction reactions, pH change, temperature change and microbiological attack.

This study which was carried out at the Milk Marketing Board, Research and Development Laboratory Shinfield Reading, England was to determine the effect of the changing pH and heat processing on some of these natural food colours used in dairy products.

Materials and Methods

Food colours used in the study are presented on **table 1**. Various manufacturing companies supplied the colours samples.

Dairy Products

A laboratory liquid milk product, Ultra-High-Temperature (UHT) processed flavoured milk drinks and yoghurt was used in the study.

The liquid milk product was prepared using fresh whole milk, 0.5 percent (w/w) starch powder obtained from National Frigex Starch Company, and 4.0 percent (w/w) sugar granules. Sugar and starch are blended dry. The milk was heated to 40°C, the starch and sugar mixture was dispensed in the warm milk. The mixture was well stirred and heated to 90°C with intermittent stirring. The product was then cooled and stored in the cold room for use the next day. To obtain the acid product, lactic acid was added.

Preparation of colours solutions

Instructions for the preparation of colour solutions or suspensions were contained in the data sheets of the colour manufacturers. The colours were prepared

Table 1. Natural food colours used in the study

Colour	Description (in solution or suspension)	pH
Pure malt products	Red-brown	3.42-3.63
Annatto powder	Yellow-orange	8.82
Annatto liquid	Yellow-orange	4.28
Bixin WD liquid clear	Yellow-orange	7.20
Oleoresin carrot powder	Orange	4.45
Oleoresin paprika liquid	Orange-red	3.60
Copper chlorophyllin powder	Green	9.26
Copper chlorophyllin liquid	Green	3.30
Cochineal powder	Red	9.82
Carmine liquid	Red	10.86
Curcumin powder	Yellow	4.69
Vegetable carbon	Black	7.12
Colarome brown (caramel) powder	Brown	3.48
Beet root powder	Yellow	4.69

by weighing the desired quantity, for example, 1mg if the concentration of the solution was to be 1mg/100ml water. The colour substance was made into a paste with some cold distilled water. Boiling distilled water was added and the mixture well stirred and the volume was made up of 100ml mark with more distilled water.

Concentrated liquid colour samples were measured and diluted accordingly.

Distilled water was used as solvent for most colours samples except circumin powder that was dissolved in alcohol. The colour samples wee prepared just before use. The pH of the colour solutions was recorded.

Application of Natural Food Colours

Four natural food colours were applied to UHT flavoured milk drinks as follows. Cochineal and beet root for strawberry flavour; Curcumin for pineapple flavoured and Annatto for banana flavour. UHT processing means sterilization at 136°C for 4 seconds. For UHT milk drinks, 500kg of fresh milk of 0.5 percent butterfat, 4 percent sugar, 0.1 percent stabilizer, flavours and colours were used. A small scale **UHT ALFA-LAVAL** plant was used. The following natural food colours, cochineal, enocyanin, beet root and curcumin were also applied to yoghurt for the various flavours. The colours were added to the yoghurt milk before fermentation and to yoghurt after fermentation. The yoghurt wad made at a laboratory scale with 8kg of semi-skim fresh milk, sugar, starter culture and colours. Incubation temperature was 40-42°C.

Measurement of Colour Stability

Colour measurement was by visual comparison with uncoloured product and colour solution as the references. Colour intensity was recorded as intensely coloured (IC) or lightly coloured (LC). There was observation for change of shade (colour). The colour solution was added to the liquid milk product at the temperature from the storage room (10°C) and pH of product as made (6.63; 6.78; 6.87) or pH as adjusted (4.08; 4.30). measurements were done in duplicate samples using glass breakers.

The pH was measured using a Kent EIL 3055 Electronic pH meter.

Results

Results, which are summarized on **tables 2-4**, show that most of the colours were stable to pH changes. Beet root powder decreased in intensity at boiling temperature and at UHT processing (136°C/4S) of liquid milk product (**table 3**) and (**table 4**). The natural food colours, Cochineal, Beetroot, Enocyanin and Curcumin were all stable to pH changes during the fermentation of milk to yoghurt at a constant temperature range of 40-42°C (table 3). When applied to UHT processing (136°C/4 seconds), the natural food colours, Cochineal and Beet root powder were unstable, while Curcumin and Annatto were stable (**table 4**).

Discussion

In the study Beetroot powder was unstable in boiling liquid milk product. Cochineal powder and Beetroot powder were destroyed during UHT processing. This observation is supported in the literature that carotenoids in general, are heat sensitive (King, 1980). Beet root belongs to the carotenoids of the root vegetables, while cochineal is an insect extract that belongs to the haem group of pigments. All these are destroyed at high processing temperatures (Lee 1983). However, these food colours are recommended for use mostly in cheese and cheese spreads (FAO/WHO, 1973) which are processed at not very high temperatures. Meanwhile Annatto and Curcumin were stable at UHT processing. The main colouring pigment contained in Annatto is Bixin, which is an apocarotenoid. Bixin forms water-soluble salts in alkaline solutions which should be responsible for the colour heat stability

Table 2. Scores for stability of natural food colours in liquid milk products

Colour	Concentration in product(mg/100ml)	pH of Product	Score at 10°C	Score at Boiling
Malt extracts, Bixin WD	1000	6.78	IC	IC
Beet root powder	100	6.78	IC	LC
Oleoresin carrot powder, Carmine	100	6.78	IC	IC
Enocyanin Annatto powder, vegetable carbon	10	6.78	IC	IC
Copper Chlorophyll in Cochineal and Curcumin powder	1	6.78	IC	IC
Malt extracts, Bixin WD	1000	4.30	IC	IC
Beet root powder	100	4.30	IC	IC
Oleoresin carrot powder, carmine, Enocyanin	100	4.30	IC	IC
Annatto powder, vegetable carbon	10	4.30	IC	IC
Copper Chlorophyllin, Cochineal and Carmine powder	1	4.30	IC	IC

Table 3. Scores for stability of natural food colours in yoghurt

Colour	pH of Cultured milk	pH of Yoghurt	Score in Cultured milk	Score in Yoghurt
Cochineal	6.55	3.63	IC	IC
Beet root	6.55	3.54	IC	IC
Enocyanin	6.55	3.63	IC	IC
Curcumin	6.55	3.64	IC	IC

Table 4. Scores for stability of natural food colours in flavoured milk drinks

Colour/flavour	pH of Raw mix	pH of UHT product	Score in Raw mix	Score in UHT product
Cochineal/Strawberry	6.73	6.67	IC	LC
Beet root/Strawberry	6.70	6.58	IC	LC
Curcumin/Pineapple	6.69	6.60	IC	IC
Annatto/Banana	6.70	6.60	IC	IC

(Coultate, 1984). Curcumin belongs to the anthocyanins which are said to be fairly heat stable (King, 1980).

From the study, pH changes do not have any visual detectable shade depending on the redox potential of the environment, at pH 2-red; pH 7-purple and pH 10-blue (Coultate, 1984; Von Elbe, 1986). However, there was no change with enocyanin powder, which belongs to the anthocyanin group of pigments. Enocyanin could not manifest its pH sensitivity because the pH range (3.53-6.78) of products used in the study did not attain the values required for change of shade. The betalaine pigments are also said to be pH sensitive (Lee, 1983) but beet root extract was stable to pH changes. Stability of beet root powder to pH changes is supported by other studies by Lee (1983), where the spectrum for betalaines at 537nm was maximum within pH range 3.5-7.0.

Conclusion

All fourteen (14) natural food colours were stable within pH range 3.53-6.87. One natural food colour (beet root) was destroyed at boiling temperatures and UHT processing (136°C/4S), and another natural food colour (Cochineal) was destroyed only at UHT processing. The natural food colours cochineal, beet root, enocyanin and curcumin are recommended for colouring flavoured yoghurt. Cochineal and beet root may be used for strawberry flavoured milk drinks at processing temperatures 70-80°C. While curcumin and annatto may be used for pineapple and banana flavours respectively at UHT processing. The other colours may be used for other flavours under the conditions of the study.

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