

## Physico-chemical attributes to develop formulation of ice cream mix utilizing whey concentrate preserved by hurdle technique

**Revised title: Developing formulation of ice cream utilizing preserved whey protein concentrate and characterizing their physico-chemical traits**

### Abstract

Whey (directly write about whey protein concentrate; instead of whey) is a source for a number of high-quality proteins, carbohydrates, minerals and water-soluble vitamins and presence of all these components makes it a highly nutritious product. The composition of whey varies with the type of whey, pH and pre-heat treatment given to whey; Whey proteins are highly nutritious food supplements having therapeutic benefits too. The biological components of whey include Lactoferrin,  $\beta$ -Lactoglobulin,  $\alpha$ -Lactalbumin, glycomacropeptides and Immunoglobulin. Ice cream is a frozen product obtained from milk along with required milk products, cane sugar, stabilizers, emulsifiers and edible flavours and colours. The present study pertains to characterizing the ice cream incorporating whey protein concentrate for their physico-chemical properties. (Need to indicate 'concluding' remarks for the findings made in this research)

Abstract needs to be rewritten entirely

The matter put under Abstract seems like Introduction part of manuscript.

**Keywords:** Whey proteins, Physico-chemical properties, Ice cream, hurdle technology, preservation

### Introduction:

Whey solids are well known for their nutritional properties and functional traits (here I suppose therapeutic virtue was in mind while mentioning 'functional') and these aspects are well documented (Muvihill, 1991; Mann, 1998; Jayaprakasha et al., 1999). Owing to their excellent nutritional and functional properties (viz., water binding, emulsifying, aeration, etc.) of whey solids (especially with high protein content i.e. WPC,

WPI?? – not whey powder!!), they find numerous applications in food and dairy industry (Jayaprakasha *et al.*, 2005; Hufmann, 1996; Mann, 1998 – arrange references in ascending order of year!). The discharge of whey without treatment leads to environmental pollution in terms of public health hazard(not necessarily). Strict and stringent regulations imposed by pollution control board and also by the environmental agencies made(printed 'mode') scientists to look for the better ways of utilizing whey in human chain.

Whey represents about 80 to 90 per cent of original volume of milk used for preparation of cheese, paneer, chhana etc. In India the quantity of whey produced annually is estimated to be more than 3 million tonnes which accounts to about 12 lakh tones of valuable milk solids in terms of nutrients (Khamrui and Rajorhia, 1998; Kim *et al.*, 1987 – Too old Ref. to be quoted in 2023?). Dwell more on whey concentrate, rather than whey – whey contains just 1-1.5% protein while Whey concentrate can contain proteins ranging from 5.0 to 6.5 % or so. You have used Whey concentrate, not whey!!

An interesting possibility for the utilization of whey for human nutrition is the hydrolysis of lactose into glucose and galactose (Renner and Abd El- salam, 1991). Hydrolysis generally improves desirability (Geilman, 1993), by increased osmotic pressure, easier digestibility, increased solubility, increased sweetness and enhances fermentability (Cotton, 1980, Arndt and Wehling, 1989; Timmermans, 1997).(have you hydrolysed lactose in whey concentrate or in unconcentrated whey?)

Whey contains valuable lactose and proteins. Almost about 80 per cent of whey is wasted without being used in country(this was the case earlier; now no longer wasted to that extent - whey powder, WPC/WPI, whey based drinks, Ricotta cheese etc. are produced to salvage whey). Whey carries low total solids(specify TS) and has very low shelf life.(As per title, you utilized whey concentrate – deal with that instead of its raw material – whey?)

Hurdle in food is defined as the use of substances or processing parameters or various preservation factors, inhibiting the growth or causing death of various

microorganisms (inhibiting growth does not necessarily kill microbes!). Hurdle concept in food context was first introduced by Leistner (1994) and according to such concept each preservation parameter is termed as hurdles. Thus, the parameters like water activity ( $a_w$ ), pH, redox potential, heat treatment, etc, which maybe bacteriostatic or bactericidal are hurdles. These hurdles may govern many preservation processes and more than one hurdle is often responsible for long shelf life of some specific food products (Leistner, 1994). Whey concentrate was preserved through combination of lowering the water activity (0.92-0.94%), decreasing the pH (i.e. to 5.2) of such media and incorporating potassium sorbate (0.2%), to achieve a storage life of about 3 months (at what temp.?).

The most delightful way to consume dairy solids and all the goodness of it is certainly through ice cream delicacies. It is not only a glamorous food but also a delicate, delicious, palatable and highly nutritious food. Although ice cream and frozen desserts market in India is witnessing a respectable growth in recent years as a result of innovations in functional ingredients, technology, distribution and communication, yet the per capita consumption of ice cream in India is one of the lowest (i.e. 0.1 L) in the world (Ravindra, 2004).

In this article per capita consumption is mentioned 0.25 Litre

Gnanamkonda Vijayudu and Prasad V K Satya (2014). Consumer awareness and consumption pattern of probiotic & sugar free ice creams in Hyderabad & Secunderabad. Zenith Int. J. Business Econ. & Mgt. Res., 4(4): 162-171.

Ice cream is one of the fastest growing dairy products with a growth rate of 25-35 per cent (per annum? Provide Ref., is it for India?). Now a days there is great demand for low-cost ingredients which provide desired functional properties. Whey concentrate is a better alternative (to what?) and can certainly meet requirements (which requirements?). Replacement of milk solids with such byproduct, in concentrated form, in ice cream production not only can reduce the cost of production but also improve its functional (what do you mean by functional – specify clearly – physical properties of health booting

ones?) properties. Whey solids have been used to replace part of the conventional MSNF sources (it has never been used to replace 100% - not feasible too!) in several varieties of ice cream formulations. Make next sentence \_\_\_\_\_ author (provide Ref.) recommended the use of dried whey at usage rate of 30-40 per cent of MSNF, without adversely affecting the organoleptic quality of ice cream. Steinsholt (1974) successfully replaced 20 per cent of usual MSNF source (which was conventional MSNF source?) in ice cream mix with whey solids without any adverse effect on its sensory quality. Lactose, if added in higher concentration (why would anyone add lactose powder in ice cream – whey concentrate contains higher lactose than the whey from which it is made! – write in a different way) causes (there is nothing like ‘higher’ sandiness!) sandiness in ice cream; however this defect can be tackled by hydrolyzing the lactose present in whey (Arbuckle, 1986 – use some recent Ref.; see Ref. of Osmak et al. 2021- there are more too!).

Tetiana Osmak, Stanisław Mleko, Oksana Bass, Artur Mykhalevych and Uliana Kuzmyk (2021). Enzymatic hydrolysis of lactose in concentrates of reconstituted demineralized whey, intended for ice cream production. *Ukrainian Food J.*, 10 (2): 277-288.

Therefore, it was envisaged to develop formulation of ice cream mix utilizing whey concentrate in which lactose was pre-hydrolyzed and the concentrate preserved through use of hurdle technique. The process of preparing such ice cream was standardized and the products keeping quality was monitored during storage.

## **Materials and methods:**

### **Materials:**

The following materials were used in the study for the preparation of ice cream utilizing lactose hydrolysed whey concentrate.

### **Whey**

Fresh cheese whey (which cheese gave such whey? At what stage – after rennet curd cutting, or after cooking of cheese curd?) was procured from SRS NDRI Adugodi

Bangalore(deleted last few words). Paneer whey was procured from Students experimental dairy plant, Dairy Science College, Hebbal, Bangalore.

### **Enzyme**

**Lactozyme ( $\beta$ -galactosidase)** was supplied by Novozymes south Asia Pvt Ltd, Bangalore(deleted last part). The enzyme had an activity of 3000LAU/ml and type HG-HG (high purity in glycerol).

### **Citric acid**

Food grade quality citric acid procured from the local market was used for preparation of paneer and for pH adjustment (why separately pH adjustment was necessary; paneer making itself will change the pH of whey)of paneer whey.

### **Whole milk**

Fresh cow milk procured from Student Experimental Dairy Plant, Dairy Technology Dept at Dairy Science College, KVAFSU was used in preparing ice cream.

### **Cream**

Fresh cream obtained by separating the cow milk in cream separator was used for ice cream mix preparation.

### **Skim milk powder**

“Nandini” brand skim milk powder manufactured by Karnataka Milk Federation was procured from the local market(deleted last part).

### **Stabilizer and Emulsifier**

Stamulcol ULV-1000 procured from Lucid Colloids Ltd., Jodhpur was a blend of stabilizer and emulsifier.

### **Flavour**

Bush brand vanilla flavour was procured from local market(which type of flavour was it – Natural, Nature-identical or Synthetic?).

### **Sugar**

Good quality(which test did you perform to rate it 'good quality?') cane sugar was purchased from the local market

### **Utensils and Glasswares(it is one word)**

Stainless steel vessels of varying capacities and Stainless-steel stirrers were used at various stages of the investigation. Conical flasks, beakers, volumetric flasks, measuring jars of Borosil make were used for chemical and microbiological analysis. Glass wares were cleaned by detergents and sterilized using Hot Air Oven at 160-180°C for 2 h and used for microbiological tests.(No need to mention this entire paragraph)

### **Evaporator**

Single effect, rising film vacuum operated evaporator (Anhydro, Copenhagen, Denmark)of 35kg water evaporation/h capacity was used. (deleted last part)

### **Analytical methods**

#### **Fat**

Fat content of milk and Ice cream mix was determined by Gerber method as per BIS (1981).

#### **Milk Solids-Not-Fat (MSNF)**

MSNF content of milk was measured using ISI certified Zeal Lactometer by using the following formula

$$\text{SNF (\%)} = 0.25 \text{ CLR} + 0.2 \text{ F} + 0.48$$

Where, CLR-Corrected Lactometer Reading

## F-Fat content in per cent

### Total Solids (TS)

Total solids of milk and Ice cream were determined by gravimetric method as per BIS (1981).

### Protein

Nitrogen content of Ice cream was determined by Micro-Kjeldahl method and protein content was computed by multiplying nitrogen value with 6.38 (BIS, 1981).

### Moisture

Moisture content of dried products was determined according BIS(1981). Why only dried products – you should find TS of unconcentrated paneer whey, cheese whey, etc.

### Ash

The ash content was determined following the standard procedure (BIS, 1981).

### Lactose

Lactose content was determined (estimate means 'rough' – better to avoid that) by Lane-Eynon method.

### Physico-chemical properties

The methods employed to analyze the physico-chemical attributes of milk, cream, and ice cream (why whey concentrate was left out?) are described below.

### pH

pH of the sample (which sample – whey, milk, ice cream?) was measured using a digital pH meter. (Elico Pvt. Ltd.) at 25°C. About 20 ml of representative samples were used for pH determination.

### **Titratable acidity**

Acidity was measured as per standard method (BIS, 1981).

### **Specific gravity**

Specific gravity of samples (of which sample?) was measured at 20°C by using a Standard specific gravity bottle of 25ml capacity by taking distilled water as a standard liquid.

### **Viscosity**

Viscosity of samples (of what? Ice cream mix?) was measured using Falling Ball Viscometer at 20°C (Gilmont Instruments, USA). The temperature of the product was maintained at 20°C in water bath using cold water. (Can provide Reference and avoid writing the entire procedure) The measuring tube was filled with the samples and the ball was inserted through the open end of the tube. Depending upon the falling time of the ball and the expected viscosity, different balls were used. The time taken by the ball to fall through a distance of 100 mm was measured accurately using  $\frac{1}{10}$  sec stopwatch. The viscosity was calculated by using the following formula.

$$\mu = K (\rho_t - \rho) t$$

Where,  $\mu$  = Viscosity in (cP)

$t$  = falling time of ball (min)

$\rho_t$  = Density of the ball (g/ml)

$\rho$  = Density of liquid at measuring temperature (g/ml)

$K$  = Ball constant (0.3)

## Melting resistance

Melting time of ice cream was observed by weighing 10 g of sample (10 g of sample is too small quantity for such testing – wrongly followed procedure!) onto a wire gauge placed on a funnel over a beaker. The time taken by the sample to completely meltdown and fall into a beaker at room temperature (what was room temp.?) was recorded and expressed as melting time in min (Arbukle, 1986).

I can show you more than 10 References utilizing 100 g of ice cream; 10 g is not appropriate for 'melting resistance test'.

Melting time: The heat shock resistance of the ice cream was determined by using a self-manufactured system. The melting time of one hundred grams of ice cream kept at 20°C to melt completely in the chamber was measured. The initial temperature of the ice cream was set to be -70°C. The onset melting time of ice cream was initiated at the point of weight change. The weight of the ice cream was determined every 1 min.

*Korean J. Food Sci.*, 34(6), 757-762(2014) Studies on physical and sensory properties of premium vanilla ice cream distributed in Korean market. Mi-Jung Choi and Kwang-Soon Shin

## Whipping rate

During freezing of ice cream mix at a regular interval of 2 min a standard volume of mix (upon freezing ice cream will be drawn out, not mix!!) was drawn and the overrun was calculated. The time taken by the mix to (what was initial start time – which stage?) attain 90 per cent over run was computed to find out the rate of whipping.

## Overrun

The overrun of ice cream was calculated on weight basis using a standard (why standard – who gave this standard BIS?) 50 ml, cup by using sensitive top pan balance. Calculations were made using the following formula.

$$\% \text{ Overrun} = \frac{A-B}{\text{-----}} \times 100$$

B

Where A-weight/unit volume of Ice cream mix

B-weight/unit volume of Ice cream

### **Penetration value**

Using a cone penetrometer (deleted 'Made by') Associate Instruments Manufactures India Ltd.) penetration value was determined after hardening (should have been at deep freeze temp. (i.e.  $-18^{\circ}\text{C}$  and not hardening temp. which could be  $-25^{\circ}\text{C}$ ?) of ice cream. The distance in millimetre by which the cone travels in 5 sec(print 'second' as 's') of the sample was noted. For each sample reading were recorded at 3 different spots and the mean value was noted. (There is not Table showing penetrometer reading, % OR in ice cream, Freezing point of ICM etc.)

### **Freezing point**

The freezing point of the ice cream mix was determined (deleted 'by') using a Cryoscope (Cryostar I 'Advanced Milk Instruments Manufacturer', USA).

### **Statistical analysis**

Completely randomized design (CRD) with one way analysis of variance (ANOVA) and simple t-test were used for analysing the data generated in the experiment. The tests of significance were carried out as per the SPSS -10 statistical packages.

### **Results and Discussion:**

#### **Physico-chemical properties of cheese whey**

The physico-chemical characteristics of the cheese whey used in the experiment are presented in Table -1 and 2.

#### **Physical properties**

Cheese whey had an average pH of 5.42 with **titratable** acidity of 0.21 per cent lactic acid. The average values of specific gravity, viscosity (cP) and water activity ( $a_w$ ) of cheese whey were (~~delete 'found to be'~~) 1.024, 1.069 centi poise and 0.995 respectively. The pH of cheese whey varied between 5.39 to 5.45.

### **Chemical composition of cheese whey**

The cheese whey had 6.68 per cent **TS** (Table 2).

UNDER PEER REVIEW

**Table 1: Physical properties of cheese whey**

<b>Properties</b>	<b>Cheese whey</b>	<b>Range</b>
<b>pH</b>	5.42	5.39-5.45
<b>Acidity (%LA)</b>	0.21	0.20-0.22
<b>Specific gravity</b>	1.024	1.021-1.027
<b>Viscosity(cP)</b>	1.069	1.066-1.072
<b>Water activity(a<sub>w</sub>)</b>	0.995	0.992-0.998

Keep 1<sup>st</sup> column matter left aligned

**Table 2: Chemical composition of cheese whey**

<b>Constituents</b>	<b>Average %</b>	<b>Range %</b>
<b>Total solids</b>	6.68	6.58-6.78
<b>Protein</b>	0.83	0.80-0.86
<b>Fat</b>	0.35	0.33-0.37
<b>Lactose</b>	4.90	4.7-5.10
<b>Ash</b>	0.60	0.5-0.70

The TS was made up of 0.83 per cent protein, 0.35 per cent fat, 4.9 per cent lactose and 0.60 per cent ash.

### Process optimization for the preparation of plain whey concentrate

Plain whey concentrate was prepared by condensing the fresh whey to different TS levels (40-55 per cent) in a falling film evaporator. (what was vacuum and temperature during condensing?)

### Effect of condensing whey on the physico-chemical properties of whey concentrate

Fresh cheese whey was condensed to TS levels (40, 45, 50 and 55 per cent). The physical properties of condensed whey prepared are depicted in Table-3. With the increase in concentration, the pH decreased from 4.98 (keep 2 digits after fullpoint) to 3.84. The pH of whey was 4.98 at 16 (control – earlier you wrote TS of whey was just 6.68 per cent – how it increased to 16.0 per cent??) per cent TS, whereas it was 3.97, 3.96, 3.88 and 3.84 at 40, 45, 50 and 55 per cent TS. The acidity tended to increase as the TS of whey concentrate was raised. At total solids 16 (control) per cent; the acidity was 0.613 per cent LA whereas at 40 per cent total solids it was 1.078 per cent LA.

The specific gravity of 16 (control) per cent TS whey concentrate was 1.057 whereas at 40 per cent TS it was 1.297. With an increase in the TS level there was a proportionate increase in the viscosity. The viscosity of whey concentrate 16 (control), and those condensed to 40, 45, 50 and 55 per cent TS was 1.24, 17.01, 19.08, 22.94 (all made to 2 digits after fullpoint) and 26.81 cP, respectively. Similarly, with an increase in the TS level there was a progressive decrease in the water activity of the whey

concentrate. The water activity ( $a_w$ ) of **whey concentrates** was 0.983, 0.942, 0.923, 0.901 and 0.886 at 16 (control), 40, 45, 50 and 55 per cent **TS levels** respectively.

The increase in the **TS level** as a **result of further condensing** was found to be **statistically significant** ( $p < 0.05$ ). The protein content at 16, 40, 45, 50 and 55 per cent TS of whey concentrate was **(deleted 'found to be')** 1.99, 4.98, 5.58, 6.21, 6.68 **(made to 2 digits after full point)** respectively and the result was found to be significant ( $p < 0.05$ ). The fat content of **whey concentrate** at 16, 40, 45, 50 and 55 per cent TS was **(deleted 'found to be')** 0.84, 2.10, 2.36, 2.62 and 2.88 respectively and the result was found to be significant ( $p < 0.05$ ). **(At which specific TS levels, was the difference significant?)**

The lactose at 16 per cent (control) **TS of whey concentrate** was 11.74 **per cent** whereas at 40 per cent it was 29.92 **per cent**. **With an increase in the TS level of whey concentrate,** there was **a proportionate increase in the lactose content**. The lactose **content at whey concentrate TS** of 16 (control), 40, 45, 50 and 55 per cent was 11.74, 29.92, 33.03, 36.68 and 40.34 **per cent** respectively. Similarly, with an increase in the **TS level,** there was **a progressive increase in the ash content of whey concentrate;** the values were 1.43, 3.58, 4.04, 4.48 and 4.94 **per cent as noted** at 16 (control) 40, 45, 50 and 55 per cent **TS of whey concentrate** respectively **(write Table no.)**.

**Table 3: Effect of degree of condensing on the physico-chemical properties of whey concentrate (it is no longer whey?)**

Level of TS (%)	Physical attributes					Chemical Composition			
	pH	Acidity (%LA)	Specific gravity	Viscosity (cP)	Water activity (a <sub>w</sub> )	Protein(%)	Fat(%)	Lactose(%)	Ash(%)
<b>Control (16)</b>	4.99	0.61	1.057	1.24	0.983	1.99	0.84	11.74	1.43
<b>40</b>	3.97	1.08	1.297	17.01	0.942	4.98	2.10	29.92	3.58
<b>45</b>	3.96	1.15	1.310	19.08	0.923	5.59	2.34	33.03	4.04
<b>50</b>	3.88	1.18	1.317	22.94	0.901	6.21	2.62	36.68	4.48
<b>55</b>	3.84	1.24	1.322	26.81	0.886	6.68	2.88	40.34	4.94
<b>CD</b>	0.036	0.032	0.006	0.17	0.004	0.017	0.064	0.058	0.018

\*All values are average of three trials

(Made 2 digits after full-point for pH, Acidity, Viscosity values, protein and fat content, as applicable)

**Effect of varying sugar levels and vacuum condensing on the physico-chemical properties of whey concentrate**

Fresh Cheese whey added with an optimum level of sugar was subjected for condensing to best accepted level. The effect of level of condensing on various physical properties of condensed whey is depicted in Table-4. With the increase in concentration, the pH decreased from 4.987 to 3.77. The pH of whey was 4.987 at 0 (control) per cent sugar, whereas it was 3.99, 3.95, 3.89 and 3.77 at 10, 12, 14 and 16 per cent sugar levels respectively. In contrast to the pH, acidity increased as the sugar addition with condensing level increased. At sugar 0 per cent (control), the acidity was 0.613 per cent whereas at 16 per cent sugar it was 1.30 per cent.

The specific gravity at 0 (control) per cent TS (should it be whey concentrate or TS??) was 1.057 whereas specific gravity of whey concentrate of 16 per cent TS was 1.325. With the increase in the total solids level there was proportionate increase in the viscosity. The viscosity (of what? – write whey conc.) at 0 (control), 10, 12, 14 and 16 per cent sugar levels was 1.24, 17.02, 19.09, 22.33 and 27.52 cP respectively. Similarly, with the increase in the sugar level there was progressive decrease in the water activity of whey concentrate. The water activity ( $a_w$ ) was 0.983, 0.925, 0.908, 0.882 and 0.879 at 0 (control), 10, 12, 14, and 16 per cent sugar levels.

**Table 4:Effect of varying sugar levels and vacuum condensing on the physico-chemical properties of wheyconcentrate**

Sugar level (%)	Physical attributes				
	pH	Acidity (% LA)	Specific gravity	Viscosity (cP)	Water activity (a <sub>w</sub> )
<b>Control</b>	4.99	0.613	1.057	1.24	0.983
<b>10</b>	3.99	1.076	1.312	17.02	0.925
<b>12</b>	3.95	1.163	1.315	19.09	0.908
<b>14</b>	3.89	1.191	1.321	22.33	0.882
<b>16</b>	3.77	1.30	1.325	27.52	0.879
<b>CD</b>	0.089	0.084	0.007	0.0178	0.009

\*All values are average of three trials

**Effect of varying sugar levels and vacuum condensing on chemical composition of wheyconcentrate**

best accepted level(There is nothing like ‘best accepted level’ – if you wish mention ‘optimized TS level of whey concentrate). The increase in the TS content of condensed whey was commensurate with the level of addition of sugar; such effect was found to be significant ( $p < 0.05$ ) (Table 5).(at which specific levels of sugar, was the effect significant?) With an increase in the level of sugar in whey concentrate, there was a progressive decrease in the protein content. The protein content of control(did control also contain added sugar – if not specify that too!)and whey concentrate having 10, 12, 14 and 16 per cent sugar was 1.99, 4.98, 4.72, 4.33 and 4.15 respectively; such effect was significant( $p < 0.05$ ).(Was effect

significant at each 2% level increase in sugar content – verify)The fat content of control (did control have added sugar?), and those containing sugar at levels of 10, 12, 14 and 16 per cent was 0.84, 2.08, 2.06, 2.03 and 2.01 per cent respectively; such effect was also found to be significant ( $p < 0.05$ ). (was the effect significant at each level of sugar added?)

The lactose content of control ice cream was 11.74 per cent, whereas at 16 per cent sugar level the lactose content was 35.04 per cent. With an increase in the sugar level, there was a proportionate increase in the lactose content of whey concentrate (statement is wrong – total carbohydrate content can increase; lactose content would decrease!!). The lactose (should be total carbohydrates – not lactose) content for control and those containing added sugar at levels of 10, 12, 14, and 16 per cent was 11.74, 29.92, 32.33, 33.56 and 35.04 per cent respectively. With increasing level of sugar addition, there was a progressive decrease in the ash content of whey concentrate (rather the ash content should rise, since sugar also has ash in it!). The ash content was 1.43, 3.58, 3.45, 3.37 and 3.22 of control as well as of experimental samples containing sugar levels of 10, 12, 14 and 16 per cent respectively.

**Preparation of lactose hydrolysed sweetened? concentrated whey (do not write 'sweet' In dairy terminology, 'sweet' means not-acidic too)**

Whey (in concentrated or unconcentrated form (be specific) – why sugar level was not reduced, since lactose hydrolysis makes such lactose-hydrolyzed whey sweeter than its untreated counterpart!!) was subjected to lactose hydrolysis. Deleted 1 sentence. The enzyme concentration attempted was such that about 80 per cent lactose hydrolysis was feasible, maintaining conditions such as temperature and pH (specify the temp. and pH kept; even time of incubation) as recommended by the supplier of the enzyme.

**Table 5: Effect of addition of varying sugar levels and vacuum condensing on**

**the chemical composition of whey concentrate**

Level of sugar addition (%)	Chemical Composition (%)			
	Protein	Fat	Lactose	Ash
Control (0)	1.99	0.84	11.74	1.43
10	4.976	2.08	29.92	3.58
12	4.72	2.06	32.33	3.45
14	4.33	2.03	33.56	3.37
16	4.15	2.01	35.04	3.22
CD	0.01	0.18	0.02	0.017

\*All values are average of three trials(after full-point kept only 2 digits for fat)

This para should have been mentioned earlier. The physical properties of whey used in this investigation are represented in Table-1. The physical properties of whey such as pH, acidity, specific gravity, Viscosity (cP) and water activity ( $a_w$ ) were within the range of results reported by Jayaprakasha (1992 – which type of whey was used by this author?). The whey used in this investigation had an average pH of 5.42 and its titratable acidity was 0.21 %LA. The specific gravity, viscosity and water activity ( $a_w$ ) of whey was (delete 'found to be') 1.024, 1.069 and 0995cP, respectively which were quite similar to that reported by Jayaprakasha (1992).

Table-2 represents the chemical composition of cheese whey used in this investigation. Whey had an average TS content of 6.68 per cent which comprised of 0.83 per cent protein, 0.35 per cent fat, 4.9 per cent lactose and 0.60 per cent ash. The results are in agreement with the composition of whey reported by several (delete 'earlier') workers (Jayaprakasha *et al.*, 1994; Mandal *et al.*, 1997).

Whey concentrate was prepared by condensing whey varying TS levels in combination with use of potassium sorbate(at what usage level? Is such preservative permitted to be used in whey concentrate or in resultant ice cream – if such whey protein concentrate is used ice cream is bound to have such preservative!!) followed by sweetening the whey concentrate with sugar. The results (write what exactly Table 3, 4 and 5 deals with individually) pertaining to these are presented in Table 3, 4 and 5 respectively.

From among the various levels of sugar tried, addition of 10.0 per cent sugar to whey was found to be optimum in combination with use of 0.10 per cent potassium sorbate (at what stage preservative was added; after concentration; before sugar addition, etc.?). The level (only 1 level – not levels!) of optimum sugar led to resultant ice cream having desired sweetness intensity (what about the level of sugar when whey was previously subjected to lactose hydrolysis i.e. 80% hydrolysed?).

Repetitive version below – Just conclude the final level of each parameter – degree of whey concentration, degree of lactose hydrolysis, level of sugar addition, level of preservative, etc.

Fresh whey was subjected for condensing to various levels of total solids. As the level of condensing increased from the initial 16 per cent to 55 per cent, there was proportionate decrease in pH and increase in titratable acidity which are mainly due to the concentration of the components which are responsible for pH and acidity. The increase in concentration also resulted in increase in specific gravity and viscosity of the whey concentrate (did lactose hydrolysis result in decrease in viscosity of the whey concentrate?). Similarly, as the level of TS of whey concentrate increased there was significant ( $p < 0.05$ ) decrease in the water activity (Table-3) which can be mainly attributed to the increased soluble solutes such as added sucrose (rate of K-sorbate was miniscule, do not consider that!) along with lactose and minerals. Water activity ( $a_w$ ) of the whey concentrate (was lactose part hydrolysed, was sugar included when measuring  $a_w$ ?) was 0.886. The decrease in water activity ( $a_w$ ) from 0.983 (this value was at what TS%?) to 0.886 at 50 per cent TS which resulted in increased storage stability (for how long could it be stored and at what temp.?) of the condensed whey concentrate. The decrease in the water activity ( $a_w$ ) of the whey concentrate (was lactose hydrolysed; was sugar included?) as compared to initial whey was ascribed to the effect of vacuum condensing. Deleted 1 sentence. The changes in physical properties (which specific properties – name them) as a result of concentration have been reported by several workers and our results are in agreement with their reports (Jayaprakasha *et al.*, 1997 – writing several workers, then putting only 1 Reference?). Lactose crystallization (when – just after production or during storage; at specific temp.?) was observed when whey was condensed to 55 per cent TS. Considering such finding, 50 per cent TS of whey concentrate (was whey hydrolysed, was sugar also there?) in the final product was found to be optimum in this investigation.

While increasing the level of concentration of whey from 16 to 55 per cent TS, there was a significant ( $p < 0.05$ ) increase in protein, lactose, fat and ash content of whey concentrate.

How many times will you be repeating the 'Materials and Methods' for production of whey concentrate? Fresh Cheese whey added with an optimum level of sugar was subjected to vacuum condensing from an initial TS of 16 per cent to 55% TS. From the initial 16 per cent to 55 per cent, there was proportionate decrease in pH and increase in acidity (repetitive). The increase in concentration also resulted in increase in specific gravity and viscosity of the whey concentrate. Similarly, as the level of concentration increased there was a significant ( $p < 0.05$ ) decrease in the water activity of the whey concentrate (Table-4) (repetitive – to be deleted). Water activity ( $a_w$ ) of the final concentrate (specify TS; whether whey was lactose hydrolysed?) was 0.879. The decrease in water activity ( $a_w$ ) from 0.983 to 0.879 at 16 per cent added sugar led to increased storage stability of the condensed whey concentrate (repetitive – I asked earlier, what temp. was it stored; what was its shelf life?). Deleted 2 sentences (repeat). The changes in physical properties (repeat – which specific physical properties by which specific authors?) as a result of concentration have been reported by several workers and our results are in agreement with those authors (Jayaprakasha *et al.*, 1997 – repeat – like earlier – several workers – finally only 1 author in Reference). Lactose crystallization was observed when whey concentrate contained 16 per cent sugar (was whey subjected to lactose hydrolysis?). Therefore, 10 per cent level of sugar in preparing whey concentrate was found optimum.

Again repetitive sentences (I already saw the same earlier in this manuscript itself!!) Fresh Cheese whey added with an optimum level of sugar was subjected for condensing from 16 per cent to 55 per cent total solids (I suppose it is sugar level and not TS – check it out??). From the initial 16 per cent to 55 per cent (what is it – sugar or TS?), there was proportionate increase in TS and slight decrease in fat and protein (earlier you mentioned significant increase in fat and protein, now writing slight decrease in fat and protein – check it out?) which are mainly due to the addition of sugar. Similarly, as the level of addition of sugar increased there was significant increase in the lactose (this has to be 'total carbohydrates' – not lactose – when you add sugar, how can lactose increase!!) and there was slight decrease in ash content of the whey concentrate (Table-5).

## Conclusion

In this investigation a technology (write – technology comprised of what – lactose hydrolysis, vacuum concentration of whey to specific TS level, addition of sugar, use of preservative, etc.) was developed for the efficient utilization of whey for the preparation of ice cream (deleted ‘formulated’). Such ice cream made utilizing such lactose hydrolysed, sweetened whey concentrate besides supplementing regular nutritional requirement and they would confer health (you did not study any health benefits in subjects – you cannot write such statement, when study was not conducted) benefits. The formulated ice cream not only helps in increasing the shelf life of whey (ice cream mix formulation utilizes such whey concentrate; ice cream cannot increase shelf life of whey – as written!!) but also helps in preserving whey concentrate in their natural form. The ice cream prepared utilizing such sweetened whey concentrate increased the mix viscosity resulting in smoother and refreshing nature they can provide potential profit (you have not computed profit margin or even cost of such ice cream) margins (improper conclusion – sentence needs to be reframed), which in turn add to the growth and development of dairy industry.

## References:

- Mulvihill, D.M. (1999) – should this open and closed bracket there?. Trends in production and utilization of dairy proteins products: functional properties and utilization, *Food Res.* **51**:65-73
- Mann, E.J., 1998, Lactic beverages: *Part 1. Dairy Indus. Int.* **53**: 13-14.
- Jayaprakasha, H.M. and Brueckner, H., 1999, Whey protein concentrate: A potential functional ingredient for food industry. *J. Food Sci. Technol.*, **36**: 189-204.
- Jayaprakasha, H.M. and Yoon. 2005, Production of whey protein concentrate by monitoring the process of ultrafiltration. *Asian Aus. J. Anim. Sci.*, **18**(3): 433-438.
- Huffman, L.M., 1996, Processing whey protein for use as a food ingredient. *Food Technol.*, **50**(2): 49-52.

- Khamrui, K (made capital letter), Dharampal, Rajorhia, G.S., Khamrui, K and Pal, D., 2001, Production of ready to reconstitute beverages from Cheddar cheese whey and Kinnow mandarin juice. *Milchwissenschaft*, **56**: 566-568.
- Kim, Y.A., Chism, G.W. and Mangino, M.E., 1987, Determination of  $\beta$ -lactoglobulin,  $\alpha$ -lactalbumin and bovine serum albumin content of whey protein concentrate and their relationship to food functionality. *J. Food. Sci.*, **52**: 124-128.
- Renner, E And Abd-El-Salam, M.H., (1991).(should bracket be there?) In: Application of ultrafiltration in the dairy industry. Elsevier Appl. Sci. Pub., London and New York.
- Gielman, W., Schmdit, D., Herewrth, Kennedy, C. and Path, J., 1990, Production of frozen dairy products from milk retentate. *Dairy Sci. Abstr.*, **52**(2):8476
- Cotton, G., 1980, The utilization of permeates from the ultrafiltration of whey and skim milk. *Bull. Int. Dairy Fed.*, **126**: 23-33.
- Arndt, E.A. and Wehling, R.L., 1989, Development of hydrolyzed and hydrolyzed-isomerized syrups from cheese whey ultrafiltration permeate and their utilization in Ice cream. *J. Food Sci.*, **54**: 880-884.
- Timmermans, E., 1997, Lactose derivative: Function and applications. In: Whey proceedings of 2<sup>nd</sup> International Whey Conference,(delete 'held in')Chicago, USA, 27-29 October, 1997IDF(1998 – earlier 1997, here 1998? check); pp.233-250.
- Liestner, L., 1994, Food design by Hurdle technology. Adalbert Raps-Foundation. Kulmbac, Germany.
- Ravindra, K., 2004, Ecstasy and Celebration of Life called “ice cream”. *Indian Dairyman*, **56**(6): 43-47.
- Steinsholt, K. Holth,J.M (1999). Deminerlized hydrolyzed and concentrated whey syrup in ice cream. Name of the Journal is missing. **80:20**,555-557.
- Arbuckle, W.S., 1986, Ice cream, 4<sup>th</sup>Ed.AVI Pub. Co., Inc., New York. U.S.A.(page nos. missing)

Jayaprakasha, H.M., Jayaraj Rao, K., and Lokesh Kumar, W.A., 1997, Studies on the influence of water activity ( $a_w$ ) in the stability of foods. A critical appraisal. *J. Food Sci. Technol.*, **34**:273-285. (Journal name made Italics)

Arrange the references alphabetically

UNDER PEER REVIEW