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Akhilesh Kumar Singh
Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, UP, India

DC Rai
Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, UP, India

Uday Pratap Singh
Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, UP, India

Sudhir Kumar
Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, UP, India

Correspondence
Uday Pratap Singh
Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, UP, India

Effect of different variables on physico-chemical properties of *Ashwagandha* enriched strawberry pulp ice cream

Akhilesh Kumar Singh, DC Rai, Uday Pratap Singh and Sudhir Kumar

Abstract
An experiment was conducted to improve physico-chemical properties of ashwagandha enriched strawberry pulp in ice cream. Ice cream with 10, 15, and 20 % strawberry pulp, 0.2, 0.5 and 1.0 % ashwagandha powder was prepared. Strawberry flavor ice cream (without strawberry pulp) was kept as control treatment. Ice cream samples were analyzed for physico-chemical parameter such as overrun, protien, fat, meltdown, moisture, pH. The highest score were awarded to the ice cream with 10% strawberry pulp, 0.2% ashwagandha powder and 14% sugar followed by ice cream with 20% strawberry pulp, 0.5% ashwagandha powder and 14% sugar. The ice cream samples without strawberry pulp were liked least. Overrun, protien, fat, meltdown, moisture, pH was affected significantly at 10% strawberry pulp, 0.2% ashwagandha powder and 14% sugar.

Keywords: Ice cream, Strawberry (*Fragaria ananassa*), pulp physico-chemical analysis, Ashwagandha (*Withania somnifera*)

Introduction
Ice cream is a delicious, wholesome, nutritious frozen dairy product. It provides about 4.9% protein, 13% fat and 20.3% carbohydrates. One hundred grams of ice cream give about 214 calories to our body. The annual output of ice cream industry throughout the world is more than 800 million liters (Hyde & Rothwell, 1972) [15]. The earlier use of fruit purees in sorbet has been diversified into ice cream (Friedrich, 1990). The development of new varieties of ice cream is based on either milk, cream and whey concentrates and flavored with fruit and vegetable extract (Olenev, 1989). Frozen and sugar preserved purees have also been used in ice cream manufacture (Anon, 1981).
Ice-cream is a frozen food made from a mixture of dairy ingredients, containing at least 10% milk fat before the addition of bulk ingredients, such as flavorings and sweeteners. A gallon of ice cream must weigh a minimum of 4.5 pounds and contain at least 1.6 pounds of food solids. In addition, the minimum weight of 540g/L limits the amount of air that can be incorporated, called the overrun, which is the percentage of increase in volume over the volume of mix frozen per unit total volume, to approximately the same volume over the volume of mix (Thomas, 1981) [27]. Frozen dairy desserts are classified by freezing status, involving milk dry matters that may or may not contain milk fat and whether they are aerated or not. Ice cream is the most preferred and consumed dairy product in this classification (Goff & Hartel, 2013) [11]. Ice cream is a nutritious frozen dairy dessert and it provides high energy to consumers. There is a great variety of ice cream formulations which depend on the mix ingredients. Generally, ice cream mix is composed of a mixture of milk, emulsifiers, stabilizers, sweeteners and flavorant ingredients (Koxholt, Eisenmann, & Hinrichs, 2001) [19]. Ice cream is a notable supplement to diet that has an impact on human health. A more nourishing and healthy ice cream can be produced by adding fruits, spices, protein rich constituents, probiotics and prebiotics. Several studies were performed to develop new formulations and to fortify functional properties of ice cream (Erkaya, Dağdemir, & Şengül, 2012; Sun-Waterhouse, Edmonds, Wadhwa, & Wibisono, 2013) [7, 26]. To cover the consumer demand and extend market share, more studies concerning new formulations are required.
Recently, health-conscious consumers have focused on low-fat products. Accordingly, the food industry is facing the challenge of probing for new alternatives for fat without any quality loss. Ice cream is a three-component foam system consists of a network of fat globules and ice crystals in a highly viscous aqueous phase (Prentice, 1992) [24]. Milk fat has very important

functions, such as it melts and crystallizes, is unctuous, depresses the cold sensation, contributes desirable flavor, is a solvent for added flavors, adds structure to ice cream and is the principal explanation for dryness of ice cream at extrusion (Goff, 2008) [10]. Ice cream manufacturers have replaced the fat in mixes and the largest numbers of fat replacers are carbohydrate-based, belong to hydrocolloids which are capable of interacting with water and their functionalities such as thickening, gelling, and emulsifying properties allow them to mimic the mouth-feel and flow properties in a manner like to that of fat globules in aqueous systems (Lim, Inglett, & Lee, 2010) [20].

The ice cream industry is valued worth 3000 crores which likely to jump at about 7000 crores by 2018 (PHD Chamber of Commerce and Industry, 2013). The per capita consumption is around 0.3 liter per annum which is far lower than even in Pakistan (0.7 litre), China (3 litres) and the developed countries (22 litres) (IICMA, 2013). Ice cream is a complex, partly frozen, four-phase system consisting of ice crystals, air cells, emulsified fat and a continuous serum phase containing dissolved and/or colloidal sugars, salts, proteins and stabilizers (Caldwell *et al.*, 1992). Ice cream is a valuable food containing high nutritive constituents for human health. It has cooling effect; hence it is commonly preferred in the hot summer days by consumers of all ages. It provides about 4.9% protein, 13-14% fat and 20.3% carbohydrates. One hundred grams of ice cream give about 214 calories to our body. The annual output of ice cream industry throughout the world is more than 800 million liters (Hyde and Rothwell, 1972) [15]. The solids not fat content of milk is composed of approximately 55% lactose, 37% protein, 8% minerals and others, such as vitamins, acids and enzymes (Arbuckle, 1996) [22]. The amount of SNF in ice cream mixes ranges from 9-12% and usually varies inversely with fat content. SNF are critical for texture and body of ice cream (Hegaenbart, 1996) [14]. There are several reasons for the limitations, including (1) the higher lactose content in the whey solids increases the potential of crystallization of the sugar (2) the high concentration of lactose and minerals result in the lowered freezing point (3) protein content is decreased in ice cream (Marshall *et al.*, 2003) [21]. Emulsifier is an important food additive that is used broadly in different food product to provide good texture and appearance and also play an important role to improving nutritional value and also melting time was dependent on the ice cream formulation and especially on the nature of the emulsifier (Knightly, 1959) [17].

Strawberry (*Fragaria×ananassa, Duch*.) fruit is one of the most commonly consumed berries both in fresh and processed forms. It is a rich source of a wide variety of nutritive compounds such as sugars, vitamins and minerals, as well as bioactive compounds such as ascorbic acid, carotenoids, phenolic compounds and folates, most of which are natural antioxidants and contribute to the high nutritional quality of the fruit (Tulipani *et al*., 2011; Giampieri *et al*., 2015) [28, 9]. All of these compounds exert a synergistic and cumulative effect on human health promotion and in disease prevention. Strawberry fruit is a non-climacteric fruit and should be harvested at full maturity stage in order to get the maximum marketing quality. This fruit is also highly perishable, due to high respiration rate, low mechanical resistance, and high susceptibility to the pathogen attack (Hashmi *et al*., 2013; Neri *et al*., 2014) [13]. Undesirable changes observed during postharvest include desiccation, loss of flesh firmness, mechanical injury, and Botrytis cinerea induced decay (Charles *et al*., 2009; Pombo *et al*., 2009) [5, 23].

Ashwagandha (*Withania somnifera*) is one of the most valued medicinal plant and widely used in Indian traditional health care systems for curing various diseases. It is also one of the members of GRAS (Generally regarded as safe) category of plants that can be used for therapeutic purposes (Bolleddula *et al.,* 2003) [4]. Roots of *Ashwagandha* has been extensively used in many indigenous preparations for its medicinal values such as anti-aging, aphrodisiac, cardio tonic, anti-stress, anti-inflammatory, antioxidants, hydro-regulatory, antiperoxidative, hemopoietic, rejuvenating, antitumor etc. (Mishra *et al.,* 2000). *Ashwagandha* exerts these properties because of its biochemical constituents like alkaloids and steroidal lactones (Elsakka *et al.*, 1990) [6]. Withania somnifera is reported to have several beneficial effects on male fertility, but its mode of action based on reports from human and animal studies has not yet been properly documented. Therefore, in this review, we discuss the role of herbal medicines in male infertility; provide a detailed analysis of various human and animal studies involving Withania somnifera; describe a proposed direct oxidative mechanism involving mitigation of oxidative stress as well as an indirect mechanism consisting of a gamma-aminobutyric acid (GABA)-like-mimetic pathway ameliorating hormonal imbalance through crosstalk among different endocrine glands to improve male fertility; and how Withania somnifera supplementation mitigates risk factor-induced male infertility.

Materials and method

Raw materials including milk, cream, skim milk powder, sugar, strawberry flavor, CMC (Carboxymethyl Cellulose) and fresh strawberries were purchased from local market of Varanasi Uttar Pradesh. Raw milk was tested for fat, SNF, acidity and pH following the methods of Kirk and Sawyer (1991) [16]. After washing with water, strawberries were treated in steam jacketed vessel at 80^0C for 1 minute and then the pulp was extracted by means of a fine pulper in order to get homogenous textured pulp and then cooled at room temperature. The citric acid, potassium metabisulphite at the rate of 0.08%, was added to the pulp. The pulp was filled to previously sterilized plastic can, which was then stored in deep freezer for later use.

Different treatments used in study

T_0	Control product
T_1	Ice cream with 0.2% ashwagandha powder + 10% strawberry pulp
T_2	Ice cream with 0.5% ashwagandha powder + 10% strawberry pulp
T_3	Ice cream with 1.0 % ashwagandha powder + 10% strawberry pulp
T_4	Ice cream with 0.2 % ashwagandha powder + 15% strawberry pulp
T_5	Ice cream with 0.5 % ashwagandha powder + 15% strawberry pulp
T_6	Ice cream with 1.0 % ashwagandha powder + 15% strawberry pulp
T_7	Ice cream with 0.2 % ashwagandha powder + 20% strawberry pulp
T_8	Ice cream with 0.5 % ashwagandha powder + 20% strawberry pulp
T_9	Ice cream with 1.0 % ashwagandha powder + 20% strawberry pulp

For ice cream preparation, all the ingredients were weighed using triple beam balance according to the formulation. All the dry ingredients as well as liquid ingredients were manually mixed thoroughly by stirring until a uniform mixture resulted. The ice cream mix was pasteurized at 72^{0}C for 30 minutes as described by Marshall and Arbuckl (1996) [22] to destroy pathogenic organisms. After pasteurization, the mix was homogenized in electric homogenizer as described by Berger and White (1976) [3]. The fat globules were reduced in size by homogenization in order to obtain a uniform dispersion of the fat. After homogenization, strawberry pulp, ashwagandha powder was added according to treatment. The mix was cooled down to 4^{0}C immediately in a deep freezer and stored at 4^{0}C for ageing. Ageing also increased the viscosity of the mix. After ageing, the mix was frozen at –5 ^{0}C in the freezing chamber of electrically operated batch type ice cream machine. When the desired consistency had been attained, the product was filled into disposable paper cups of 100 ml. capacity. The cups were immediately transferred to the hardening unit maintained at –25^{0}C to –30^{0}C and the ice cream was kept for 24 hours. These cups were then transferred to deep freezer at –20 ^{0}C.The data obtained in the research on different aspects were tabulated and analyzed statically using the methods of One-way analysis of variance (ANOVA).

Procedure of Methodology

Selection of ingredients
↓
Standardization of the mix
(10% Fat,12% SNF, 14% Sugar, 0.5% (Stabilizer and Emulsifier), 10-20% strawberry pulp and 0.2-1.0% -Ashwagandha powder)
↓
Pre-heating the mix (at 60 °C)
↓
Homogenization the mix (2500 psi)
↓
Heating the mix at 85±1 °C for 15 min
↓
Ageing the mix (4 to 5 °C for 5 hours)
↓
Freezing the mix (-15°C for 25 min)
↓
Packaging of control ice cream
↓
Hardening and Storage of control Ice-cream (-23 to -29 °C)

Fig 1: Process diagram for manufacturing the *Ashwagandha* enriched strawberry ice cream

Result and Discussion

Effect of different variables on physico-chemical properties of optimized *Ashwagandha* enriched strawberry Ice Cream

The results of chemical analysis are shown in Table 1. On the basis of physico chemical parameter such as pH, moisture, fat, protein and Overrun percentage the ice cream with 0.2% ashwagandha powder + 10% strawberry pulp has shown significant as compared to other treatment. Significant decrease in pH and significant increase in acidity is due to presence of ascorbic acid in strawberries. The results of this study are supported by the findings of Gwiszczynska and Kaluziak (1971) [12].

Table 1: Physico-chemical properties of strawberry pulp enriched *ice cream*

Treat-ment	Moisture	Overrun percentage	Fat	pH	Protein
T_0	64.60±0.42	41.97±0.4197	11.72±0.34	6.36±0.31	4.21±0.32
T_1	64.29±0.41	41.65±0.4165	11.86±0.44	6.36±0.33	4.11±0.36
T_2	64.34±0.40	41.49±0.4149	11.81±0.41	6.33±0.35	4.21±0.42
T_3	64.89±0.41	41.03±0.4103	11.80±0.42	6.37±0.42	4.21±0.46
T_4	65.35±0.38	40.13±0.4013	11.72±0.38	6.32±0.36	4.02±0.47
T_5	65.33±0.40	40.12±0.4012	11.62±0.36	6.30±0.35	4.18±0.42
T_6	65.87±0.36	38.01±0.3801	11.46±0.42	6.33±0.42	4.10±0.46
T_7	66.46±0.38	38.05±0.3805	11.35±0.44	6.27±0.45	3.88±0.48
T_8	66.33±0.42	36.82±0.3682	11.21±0.43	6.29±0.42	4.02±0.38
T_9	66.52±0.38	35.11±0.3511	11.12±0.45	6.26±0.38	4.13±0.36
CD 5%	0.62	0.25	00.25	0.12	0.13
SE(m)	0.21	0.08	0.08	0.04	0.04

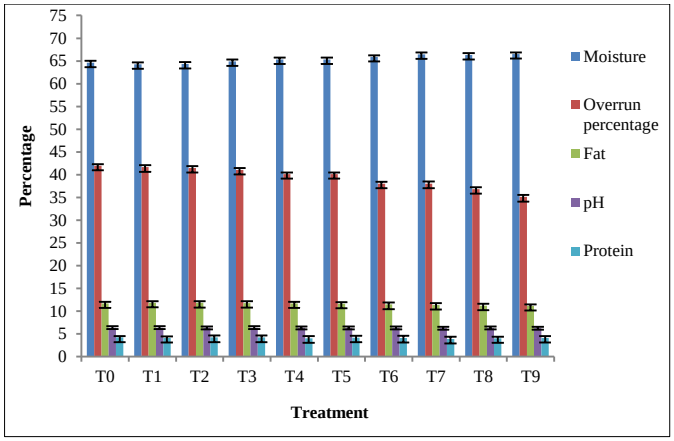

Fig 1: Effect of different variables on physico-chemical properties of optimized *Ashwagandha* enriched strawberry Ice Cream

Table 1 Shows that the Moisture score was the highest in treatment T_1 (8.78) than the lowest score was recorded in treatment T9 (6.27). The Protein score of prepared Ice cream was highest in treatment T6 (7.67) and the lowest in treatment T9 (6.17). The maximum and minimum score for Fat was recorded in treatment T_0 (8.57) and T9 (6.17) respectively. The pH score was highest in treatment T_1 (8.74) and the lowest value recorded in treatment T9 (6.80). The maximum and minimum score for Overrun percentage was recorded in treatment T_0 (8.57) and T9 (6.17) respectively It is clear from table 1 that the score obtained by treatment T1 for sensory parameters as color & appearance, flavor, body & texture and overall acceptability was (8.78, 7.61, 8.02, 8.74 respectively) highest whereas the score obtained by Control sample (T0) for color & appearance flavor, body & texture and overall acceptability was (8.48, 7.54, 8.57, 8.38 respectively) very near to the treatment T1. It is revealed from the above result that the difference in the value obtained by treatment T1 was Non - Significant (p<0.05) to the value obtained by T0 (Control) treatment.The results of this study are supported by the findings of Gwiszczynska and Kaluziak (1971) [12].

Conclusion

A new variety of ice creams particularly rich in chewy eating sensation and pleasant flavor can be manufactured by utilizing frozen strawberry fruit. Appearance, taste and mouthfeel characteristics of the ice cream improved upon the addition of the fruit. Further research is recommended to establish the

conditions for processing of strawberry fruit in different forms and levels of addition in ice cream without compromising the quality of the product. On the basis of above findings it can be concluded that the superior quality of *Ashwagandha* enriched strawberry Ice Cream can be prepared by addition of 10% of strawberry pulp, 0.2% Ashwagandha powder and 10% of sugar as the overall acceptance for treatment combination T1 was highest in all physico-chemical treatment.

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