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Nutritional, chemical and sensory evaluation of newly formulated chocolate from whey protein

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The review indicates that all major areas of interest from nutrition and health stand point and explores many of the popularly held beliefs about chocolate. An exhaustive market survey was conducted for the well established branded chocolate, which indicates that chocolate has a special identity in the diet irrespective of race religion and age group of the consumer. The general tendency was that sugar patients and the children have shown reluctance due to fear of health problem such as tooth decay. Chocolate has been accused of causing headaches and migraines promoting heart diseases, being adductive, causing dental decay, being a potent allergen, causing outbreak of acne and unreasonably leading diabetics to abandon dietary common sense amongst many other diseases. It was also found that malnourishment is prevailing at much higher rate then it was expected. The present investigation was aimed at formulating 'Healthy chocolate' to combat malnutrition among children and diabetic patients. The chocolate was formulated using whey protein concentrate, skimmed milk powder and cocoa powder. The newly formulated chocolate was analyzed for physico-chemical and aesthetic properties supported by the sensory evaluation. The nutritional level was evaluated to establish its significance in feeding the malnourished children. The microbial status of the chocolate was used to predict shelf life of the product. Chocolate was analyzed for the selected nutrient parameters like moisture, total ash value, total sugar, total protein and total fat content. The product was also characterized by its vitamin (A, B_1, C, D, E) and minerals (Ca, Mg, Fe, K) content. The analytical parameters and nutritional status was correlated with specific health related problems. It indicates that newly formulated chocolate has better acceptability and can be recommended for the safe consumption by the patients. The sensory evaluation showed the increase in organoleptic properties on long storage. The consumer survey of the product indicates the good response to general acceptability of the product.

Key Words : Nutritional, Chemical and sensory value, Whey protein, Chocolate

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INTRODUCTION

The search for food has played major role in every process of construction of human society. Chocolate is considered as a naughty but nice food. It has always a mixed response due to high fat content but considered as a luxury food product (Bruinsma and Taren, 2000). Chocolate is a concentrated high energy foodstuff. It is a food with high nutritive value with three major components like carbohydrate, protein and fat. Plain chocolate is good source of minerals and micronutrients. Chocolate makers promote the use of chocolate as everyday food even though it is a food treat for special occasion. Cocoa and chocolate are mainly eaten because of their organoleptic properties and not as a protein sources. However, it is said that chocolate can be eaten between the meals without reducing the proportional calorie intake. The fact of eating is essential to the maintenance of health determined by the biological considerations.

The refreshing quality of cocoa product is mainly due to two mild stimulants namely caffeine and theobromine (Chudle *et al.*, 2000). Both this components are neither cumulative nor habit forming but can stimulate blood circulation and excretion of urine. However, coca should be avoided by heart patients and highly nervous or dyspeptic patients. It may cause loss of sleep, palpitation and depression.

Generally, whole milk powder and non-fat milk powders are used in chocolate making. The milk powders act as an anti-blooming agent in the dark chocolates. Milk powders can be best exchanged with the cocoa butter in milk chocolates to

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make the product cost effective. Milk fat is added for enhance taste, texture modifier and fat bloom inhibitor.

The removal of casein and fat from the milk leaves whey protein as a major nutritive portion of the milk. Whey proteins have excellent nutritional and functional properties. Any foodstuff can be fortified with whey protein to make it protein rich. It can be used in baked food, beverages, cheese products, jam and jelly, frozen foods fat substituted meat, pasta and variety of milk products.

A detailed market survey was conducted by using pre-planned questionnaire. The salient features of the questionnaire include the reasons for chocolate consumption, popular brand, pre-cautionary fear of chocolate consumption, and frequency of consumption, adverse health effects, influence of media on purchases of chocolate and cost effectiveness of the chocolate.

Variety of chocolates are available in the market amongst which plain chocolate, unsweetened chocolate, milk chocolate, bitter chocolate, covertures chocolate, dipping chocolate, white chocolate and drinking chocolates are very common. Recently, dry fruits are incorporated in the chocolate to increase its acceptability and enhance its aesthetic and nutritive value.

The results of survey were interpreted by using proper statistical method and it was found that awareness related to consumption of chocolate and nutritional level is most essential. It was felt the need of chocolates with elaborate nutritional status highlighting its nutritional advantages is most wanted. The broad objectives were fabricated into research problem and new chocolate was formulated with definite goals.

Objectives:

- To formulate nutritive chocolate using whey protein and cocoa powder.
- To determine the analytical parameters of the newly formulated chocolate.
- To evaluate nutritional value and aesthetic value of the new product.
- To determine the micronutrients of the chocolate.
- To perform sensory evaluation test.
- To determine the shelf life of the product
- To correlate the nutrient levels with the possible health related problems.

METHODOLOGY

Formulation of chocolate:

the chocolate was formulated with the special goal to make it enriched in the nutrient content as well as control of calories so that diabetic patients can also consume the product. Sugar component was replaced by artificial sweetener, which automatically restricts the calorie intake. Similarly, incorporation of whey protein makes it richer with respect to available protein intake. De-fatted skimmed milk powder was used to control the total fat intake. Cocoa beans were selected which are richer in mineral content to provide trace elements in the final product.

Ingredients:

Cocoa powder, whey protein and butter were mixed in the 1:4:1 proportion and dough was made using 1 portion of cow milk. Artificial sweetener (10g) was added to the mixture. Initially, cocoa powder and skimmed milk powder were sieved to a fine 200 mesh size and melted butter was added to the mixture. Milk was added to make the soft dough and heated in the double container to 50^0C. Cooled to room temperature and removed the outer container. Kneaded the product till it becomes soft and free from granules. Added powdered artificial sweetener and kneaded again. Rolled the soft mix into a desired shape and preserved it in a cool place.

Analysis of physico-chemical parameters:

The newly formulated chocolate was characterized by different physico-chemical parameters like moisture and total ash content. The moisture content was determined by using vacuum dry method. The previously weighed chocolate was dried in the oven at 105^0C for three hours and weight loss was calculated to indicate the moisture content. Similarly, the previously weighed chocolate was ignited at 525^0C in a muffle furnace using platinum crucible for 1hour to give total ash value.

Determination of nutritional values:

The major nutritional parameters of chocolate are total protein, total fat and total sugar. Protein content was determined by using micro Kjeldahl method. Fat was extracted from the sample using petroleum ether and extracted portion was evaporated to give fat content. Total fat was estimated by using method reported in the ISI (ISI, 1984). The Fehling's method was used to determine the total sugar from the chocolate sample. Each determination was repeated three times to ascertain the reproducibility of the method and only average values are reported.

Determination of trace element:

The important trace elements are calcium, magnesium, iron and potassium. The origin of these elements is the cocoa beans which are used to prepare cocoa powder as ingredients in the formulation. The mineral concentration was determined from the total ash, which mainly contents inorganic residue of the minerals (Ronald and Ronald, 1999). Calcium and magnesium contents were estimated using complexometric titration using Erio-Chrome Black T indicator. Iron was determined by spectrophotometric method using o-phenanthroline complex of the ferrous ion. Flame photometer was used to determine

the potassium content of the chocolate. The determinations were repeated three times and only average values are reported.

Determination of aesthetic parameters by conducting sensory test:

The chocolates were tested by fifty panel members selected for the sensory evaluation test. The sensory evaluation was carried out by using composite scoring test and Hedonic test. The emphasis was given on the parameters like colour, flavour, taste, texture, softness, mouth feeling, absence of defects. The test was followed by brief survey of the existing product and desire for the new chocolates with its nutritional benefits.

Microbiological testing for shelf life of the product:

The microbiological test was performed on the new chocolate using total plate count (TPC) method. The test was performed on the fresh product as well as after regular interval of four and eight days of storage under LDPF polyester wrapper.

OBSERVATIONS AND ASSESSMENT

Preliminary survey was conducted in order to understand pattern of consumption (Seligson *et al*., 1994) awareness about the nutrients content and myths about the chocolate by using preplanned questionnaire. Summary of the survey is incorporated in the Table 1. The result indicates that chocolates were mainly consumed by 11-20 years age group. Consumer preferred chocolates with added dry fruits and nut content which improves nutrition value of the chocolates. Indirect information indicates that Cadbury brand chocolate is preferred due to its taste, flavour and texture. It seems the choice of Cadbury brand is also influenced by the media and advertisement. However, the frequency of consumption is not related to cost factor and almost 15 per cent of the consumer consumed chocolates daily. Survey also emerged with the four popular different brands of chocolates indicating their acceptability.

In order to compare various nutritional and analytical parameters with the newly formulated chocolate, an attempt was made to analyze popular branded chocolates for the similar parameters. The values of these parameters were compared with the PFA value to ascertain quality of the newly formulated chocolate. The experimental results are tabulated in the Table 2. The nutrients and minerals content were related with the specific health problems.

Moisture content involves the measurements of loss in weight due to evaporation of water (Swaminathan, 1987). The proportion of free water loss increases with the rise in temperature of heating and other related factors like particle and sample size along with organic matter. Moisture plays important role in providing smoothness and softness the food products, but higher percentage decreases its shelf life and promote growth of microorganism. Cadbury brand chocolates have maximum of 58.88 per cent of moisture, although PFA recommends moisture content in the range of 15-20 per cent only. Obviously, it will decrease the shelf life of the chocolate but addition of food preservatives can overcome this difficulty.

Table 1. Summary of consumer survey on chocolate

Age (Yrs)	%	Frequency	%	Reasons	%	Variety	%
5-10	6.00	Daily	15.00	Colour	55.00	Plain	30.00
11-20	53.00	Twice/week	14.00	Taste	89.00	Milk	11.00
21-30	28.00	Thrice/week	14.00	Flavour	47.00	Dark	15.00
31-40	10.00	Fortnight	28.00	Texture	9.00	Fruit/nut	37.00
41-50	3.00	Monthly	14.00	Acceptability	24.00	Flavored	12.00
51-60	2.00	Occasional	15.00	Cost	94.00	Any	1.00

Table 2. Comparison of chemical and nutritional composition of chocolates

Parameters/Brand	Cadbury	Nestle	Amul	Kitkat	New chocolate	PFA range
Moisture (%)	58.88	54.35	50.08	45.25	24.05	15-20
Total nitrogen (Protein)	5.6	8.7	6.4	4.5	5.4	4-5
Total sugar (CHO)	52.5	54.5	51.7	45.7	38.3	37-55
Total fat (%)	35.2	37.6	36.8	21.0	22.6	10-20
Total ash (%)	1.3	1.7	2.8	2.2	1.9	1-2
Calcium (mg/100g)	63	246	127	198	210	150-240
Magnesium (mg/100g)	131	59	34	110	107	80-120
Iron (mg/100g)	2.9	1.7	0.8	0.6	2.8	1-3
Potassium (mg/100g)	257.0	349.0	220.0	176.0	244.0	200-300

Unlike other branded chocolates, newly formulated chocolate has moisture content in the close proximity of the PFA recommendation.

Protein content is normally represented as amount of total nitrogen (Kar and Mishra, 1998). It is an important nutrient particularly for the malnourished children. Nestle brand plain chocolate has maximum protein content up to 8.7 per cent due to use of cow's milk powder in the preparation of chocolate, which has higher percentage of protein. All other brands of chocolates have protein value in the range of 4.5 to 6.4 per cent close to PFA recommendation. Newly formulated chocolate has a protein value 5.4 per cent marginally higher than the PFA value due to use of whey protein. The higher protein content makes to nutritionally richer than the other brand.

The use of sugar in chocolate is vital which provides bulking properties and offset the bitterness of the cocoa powder. Carbohydrate is very much essential nutrient of the chocolate as a instant energy supplier to any person. Ingredients like sugar, dextrose, and starch makes the total of carbohydrates in the chocolate. In milk chocolate sucrose and lactose in crumb form has great influence on the flavour of the chocolate. Washed raw sugar as an invert sugar, non-sugar like sorbitol, mannitol and xylotol are generally used as an artificial sweetener in chocolate industries. The replacement of sucrose by artificial sweetener affects both the flavour and texture of the product. All the brands of chocolate have sugar content more than recommended PFA value but new chocolate has sugar content close to lower limit of the standard. The lower sugar content but high flavour of the new chocolate is attributed to the controlled addition of artificial sweetener and proportion of cocoa used in the making of the chocolate.

PFA standard recommends total fat in the chocolate up to 10-12 per cent although all the popular brands of chocolate have much higher fat content. The higher fat concentration is due to ingredient cocoa butter which is responsible for the flavour of the chocolate. In order to achieve better acceptability of the chocolate, flavour of cocoa is essential. Nestle brand chocolate has maximum fat content (37%), while Kitkat brand has value very much close to the PFA standards. Newly formulated chocolate has 22.6 per cent of total fat which gives smoothness and soft texture to the chocolate. These total fat in chocolate is composed of monounsaturated fatty acid (MUFA) as oleic acid (35%), saturated fatty acid (SFA) as stearic acid (33%) and (5%) of palmitic acid. The other fatty acid constitutes only 5 per cent. A clinical investigation documented that stearic acid is different than other SFA due to absence of hypercholesterolemia. Kris *et al.* (1994) reported that total LDL cholesterol does not increase significantly due to consumption of stearic acid from chocolate. Detailed protein and lipid profile can be obtained by using recent HPTLC technique but it is beyond the scope of this presentation.

Flavonoids are the naturally occurring compounds found in the plant based foods, which has certain health benefit properties (Richelle *et al.*, 1999). Flavonoids act as a antioxidant and destroys the free radicals produce by the body cell during metabolic process. Literature indicates that flavonoids content of the cocoa inhibits the effect of carcinogens due to its antioxidant and free radical combating properties. Decreased susceptibility to LDL cholesterol oxidation is due to cocoa flavonoids. The antioxidant capability and reduced production of oxidative products in blood plasma is related to increased level of cocoa and chocolate flavonoids. Japanese people consider cocoa products as a nutritional supplement and functional food. A wrapper on the Japan made chocolate bar indicate chocolate as a food for the prevention of cancer, diabetic and cardiovascular diseases.

Total ash content represents the inorganic residue after igniting the product at high temperature. The residue is mainly composites of inorganic minerals in the form of their oxides. According to PFA, total ash value should be less than 2 per cent. Total ash value of the Amul brand chocolate is maximum 3.7 per cent which is more than the PFA recommendation range, while Cadbury brand chocolate show minimum of 1.3 per cent of total ash. New chocolate has ash value nearer to the higher limits of 1.9 per cent. The higher percentage of ash indicates the high mineral content in the chocolate.

All the minerals from food is absorbed in the intestinal portion and transported and stored in the different organs of the body. However, Indian diet is always poor with respect to mineral content and required additional supplements of the mineral to meet the recommended dietary allowance (RDA). Chocolate is one of the best options for such supplementary food. Hence, it is essential to investigate the newly formulated chocolate for its mineral concentration. The important minerals are calcium, magnesium, iron and potassium. Potassium is virtually ubiquitous in daily diet. Cocoa powder does not contain enough calcium but rich in available iron as a essential mineral. Cocoa contains 600mg/100g of magnesium. Milk powder and cocoa powder used in the chocolate making is responsible for the mineral content of the new chocolate. Calcium is essential mineral for the bone strength of the body. It also improves the dental caries but the sugar factor invites faster rate of microbial growth in the dental cavities. Iron improves the blood parameters and oxygen carrying capacity of the blood. It is an important nutrient for many metabolic reactions which involves redox in nature. Potassium plays significant role in maintaining the working of sodium-potassium pump action through which it regulates the cardio vascular activities. The mineral level of the branded chocolate and the newly formulated chocolate are in very close proximity of the PFA standards. Concentration level of each mineral has their merits and influence on the health. These minerals are incorporated through various ingredients of the chocolate making hence, no additional mineral supplements are required

(Rossner, 1997).

Chocolate contains sugar and fat exactly the right proportions to provide a sensory experience. Sensory evaluation is the most important test in judging the organoleptic properties of the food product (Tirumalesha and Jayprakash, 1998). This organoleptic evaluation is based on various factors like colour, taste, texture, mouth feeling and overall acceptability of the product. The quality of chocolate depends both on the quality of ingredients used and different stages of preparation of chocolate. Good chocolate is shiny brown clean and free from lumps, tiny burst bubbles and white specks. It should melt like butter in the mouth and has a true flavour of chocolate and not of cocoa powder (Hosken, 1994).

Colour is the most noticeable factor of the chocolate. Psychologically cocoa colour is normally accepted for the chocolate. Survey indicated that cream white colour of milk chocolate is usually not liked by the consumer. However, brown and dark brown colour is largely accepted by every age group consumer.

A taste rich in complex flavour is a true gain from the chocolates. Taste of the chocolate related to mouth feel and olfactory organs. It is the important criteria for the acceptability of the chocolate. Freshly prepared chocolate has better acceptability due to its freshness of cocoa flavour. On storage and consumption of chocolate after few days shows decrease in flavour and acceptability.

Flavour of chocolate is considered as taste with odor of the cocoa powder. Enzymatic reactions amongst the ingredients of the chocolate increase the flavour of chocolate. The increased in flavour increases the acceptability of the chocolate.

The combination of snappy texture in its solid form with smooth fluid from the mouth is characteristic of chocolates. Texture of chocolate must be smooth and soft and have mouth feeling effect during consumption. It should not sticky and grainy. It should be free from any physical defects since it may cause rapid growth of microorganism. Chocolate makers add extra fat to achieve texture standard prescribed by the PFA. However, it unnecessary increases the fat content of the chocolate and decreases the nutritional importance of the chocolate.

Hedonic test was performed to carry out overall acceptability of the new chocolate. Nine point Hedonic scale indicate that new chocolate had better acceptability even after eight days of proper storage.

Packaging and storage conditions play were important role in shelf life and overall acceptability of the new food products. The samples of the chocolates were diagnosed for the microbial counts and correlated with the shelf life of the product. Milk free chocolate has better shelf life up to few months if stored at 18^0F. Aroma of chocolates can be enhanced by using higher amount of unsweetened cocoa powder. Food products are prone to decompose faster than any other commodity. It is necessary to investigate the determine shelf life of the chocolate. Various factors affect the shelf life of the chocolates amongst most probable is presence of microorganism. PFA has made mandatory to perform microbial test for any food commodities. Different techniques are used to determine microbial counts of the food products. The microbial test is performed on a fresh product and at regular interval of storage (Man and Jones, 1994). The results of this test can indicate probable estimated shelf life of the chocolate. The results of microbial investigation of differently branded chocolates and new chocolate are tabulated in the Table 3.

In order to decrease the microbial count and increase shelf life of the food products certain food preservatives are permitted by the FDA*. High microbial count makes the product non-suitable for consumption. In the absence of food preservatives and high moisture content of the food product, shelf life is not expected beyond few days. However, newly prepared chocolate did not indicate growth of any fungus until 10 days of proper storage. Generally chocolates are wrapped with waxy paper and than with LDPE polyester paper. Waxy cover prevents the loose of fat from the product. The shelf life of the chocolate could have been increased beyond 10 days if the product was refrigerated.

Consumer survey of 100 members of the society from different sector and age group was carried out about the newly formulated chocolate. The whole exercise was intended to bring awareness for the nutritional importance of the newly prepared healthy chocolate and it was definitely not for the marketing purpose. The survey indicated positive response with respect to awareness and appreciated the efforts of the project. Most of the myths related to consumption of the chocolate were unfolded and indicated preparedness for the consumption of

Table 3. Summary of microbial investigation

Brand/Period	Fresh		After 4days		After 8 days	
	CFU/ml	Counts/ml	CFU/ml	Counts/ml	CFU/ml	Counts/ml
Cadbury	200	2.0×10^4	230	2.3×10^4	250	2.5×10^4
Nestle	220	2.2×10^4	280	2.8×10^4	440	4.4×10^4
Amul	450	4.5×10^4	500	5.0×10^4	760	7.6×10^4
Kitkat	390	3.9×10^4	420	4.2×10^4	690	6.9×10^4
New chocolate	300	3.0×10^4	450	4.5×10^4	610	6.1×10^4
PFA (Range)	-	$< 1.0 \times 10^4$	-	$< 2.0 \times 10^4$	-	$<4.0 \times 10^4$

new healthy chocolate. Chocolate is no more a luxury food for the children but it is a nutritional requirement for every age group consumer. In fact it can be considered as a nutritional food for the malnourished children. However, it is hard and difficult to replace existing established Cadbury brand chocolate.

Conclusions:

Chocolate is a nutritive and delightful food. It is high energy food stuff with a complex but well defined nutritional profile. It is an important source of essential minerals and can become supplementary food for the malnourished patients. In general, when consumed as part of a balanced and varied diet, chocolate can be a source of nutrients as well as pleasure and can be considered as being part of a healthful, wholesome diet. Newly formulated chocolate unfolds various facts and myths about the chocolate eating. It is health friendly and can be consumed at any time in the controlled manner. However, precaution must be taken and not to over consumed due to excess amount of fat and sugar content in the chocolate.

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