IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Volume 14, Iss 05 2025

PRODUCTION OF FORTIFIED HEALTH DRINK USING COTTON SEED MILK AND KALE LEAVES

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ABSTRACT:
The research was undertaken with the object to develop the fortified health drink using cotton seed milk blended with kale and other ingredients. The aim of our present study was to fortify the vitamin A, K, C in Health Drink using Kale leaves powder to avoid the vitamin deficiency. The ingredients used for the preparation of fortified Health Drink was optimized by using Minitab 18. The fortified health drink was analyzed for physio-chemical properties, microbial analysis, and sensory analysis. Physio-chemical properties like Total soluble solids, Ascorbic acid, Moisture Content, Carbohydrate, Fiber, Protein, fat, pH, acidity and Ash were studied. The Protein and Fat slightly decreased due to Enzymatic oxidation. The increase in total solids was due to the loss of moisture. The Acidity of sample was increased significantly while there was a decrease in pH during storage. The decrease in Fiber occurs due to its storage period and exchange of free radicals. The optimum conditions for the best sensory score of the outputs obtained were Cotton seed milk- 970g, Kale leaves powder-75g, Palm Sugar- 178g, and Corn flour-52 g. The overall scores were 8.0.
KEYWORDS: Cotton seed milk, kale leaves, fortification, Health drink

I.INTRODUCTION:

Food fortification was described as the addition of one or more important nutrients. Food whether or no longer it is commonly contained within the food, for the purpose of preventing or correcting established deficiency of one or greater nutrients inside the populace or precise population organizations. A drink that claims to be beneficial to health was called health drink and were available in a variety of flavors and was a good source of vitamins and minerals. Coffee, smoothies, shakes, juices and tea, without added sweeteners, were considered as heath drinks. Low-fat or fat-free milk; unsweetened, fortified milk alternatives; or 100% fruit or vegetable juice contain important nutrients such as calcium, potassium, or vitamin D have also come under the category of health drink. Milkshakes were cold blended dairy beverages. It was usually prepwered by milk, ice cream or iced milk, emulsifiers or stabilizers and flavorings or sweeteners such as fruit syrup or chocolate sauce. Cotton was extracted from the genus Gossypium, which was a group of flowering plants in the Gossypieae tribe of the Malvaceae family, which includes mallows. It was indigenous to the Old and New Worlds' tropical and subtropical climates. The main purpose of growing cotton was for its lint. Industrial applications of cotton seeds were linters, hulls, seed oil, and seed cake, among other byproducts. Cotton seed oil was traditionally used worldwide for salad dressing, frying vegetables, meat, mayonnaise, salad dressing and similar products because of its flavor stability and for

medicinal purpose [1]. Rich in tocopherols and linoleic acid, cottonseed oil promotes quick wound healing. Research indicates that through regulating cellular response, the omega-3 fatty acid linoleic acid facilitates the healing of wounds. Omega-3 fats have been demonstrated to have preventive effects against cancer and other diseases, as well as potential benefits in the treatment of lupus, eczema, and rheumatoid arthritis, heart disease, and stroke. One important family of polyunsaturated lipids was omega-3 fats. Leafy green vegetable kale (Brassica oleracea Acephala group) was a member of the Brassicaceae family. It has high content of bioactive compounds such as vitamin C, pro vitamin A, glucosinolates, phenolic antioxidants, dietary fiber, micronutrients (iron, zinc and manganese). Kale gives greater than 100% of the advocated everyday intake (RDI) of diet A and greater than 40% of the RDI of diet C. Therefore, kale may be taken into consideration an incredible supply of antioxidants. The extensive growth and commercialization of kale can be a realistic approach to increase the dietary intake of antioxidants in the population [2].

II.MATERIALS AND METHODS:

The following table shows the ingredients and its actual measurement used for the preparation of fortified Health Drink.

INGREDIENTS	COMPOSITION
Cotton seed milk	1000 ml
Kale Leaves powder	80 g
Palm sugar	200 g
Corn flour	16 g
Water	150 ml
Cardamom	50 g

Table: 1 Ingredients for preparation of fortified health drink

2.1 EXTRACTION OF COTTON SEED MILK:

The raw cotton seed was originally washed, and then the seeds were soaked for 12 hrs and well grinded with the help of mixer. It was pasteurized at 85 °C to 90 °C for 15 minutes, and then the cotton seed milk was cooled at 4 °C and stored for further preparation.

Cotton Seeds

Collection of cotton seeds
↓
Soaking of cotton seeds for 12 hrs
↓
Grinding of cotton seeds
↓
Filtration
↓
Pasteurization at 85 °C to 90 °C for 15 minutes
↓
Cooling and chilling to 4 °C
↓
Storage

Soaked Cotton Seeds

ISSN PRINT 2319 1775 Online 2320 7876

2.2 EXTRACTION OF KALE LEAVES POWDER:

The harvested kale leaves were well sorted, cleaned and blanched. The leaves then kept in the vacuum dryer for 20 hrs and grinded into fine powder. The grinded powder was sieved using 0.4 mm mesh and finally kale leaves powder obtained was to be used in the preparation of fortified health drink.

Kale Leaves

Collection of kale leaves
↓
Cleaning and blanching
↓
Vacuum dried for 20 hrs
↓
Grinding of dried kale leaves
↓
Sieved using 0.4 mm mesh
↓
Collection of powder

Vacuum Dried Kale Leaves Powder

2.3 PREPARATION OF FORTIFIED HEALTH DRINK:

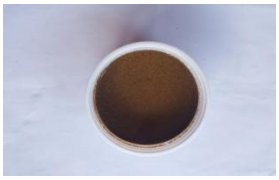
During the Preparation, the quantity of ingredients was added according in the table. The cotton seed milk was heated for 70°C for 15 min and standardized with cardamom. Then palm sugar was added to the required amount. Kale leaves powder was added, and corn flour was added to get proper consistency. Pasteurization was done at 85°C for 15 sec. The pasteurized drink was the chilled and cooled at 4°C and then stored in the refrigerator.

Cotton Seed Milk

Cardamom Powder and Corn Flour

Cotton seed milk
↓
Filtration
↓
Standardization with cardamom
↓
Addition of palm sugar
↓
Heating for 70°C for 15 sec
↓
Addition of kale leaves powder
↓
of corn flour to get proper consistency
↓
teurization for 85°C for 15 sec
↓
Chilling and cooling for 4°C
↓
Storage of fortified health drink

Palm Sugar



Fortified Health Drink

III. RESULT AND DISCUSSION:

3.1 RESPONSE SURFACE METHODOLOGY (RSM):

The Quality of the health drink was greatly influenced by the proportion of fortified health drink. Central employed to optimize the components like Sugar, kale leaves powder, corn flour and cotton seed milk, cardamom which enhance the fortified health drink preparation. The levels of these ingredients were given in Table. CCD was used to study the effect of the process ingredients towards their responses and subsequently in the optimization studies.

Independent ingredients (g)	Code	Coded levels				
		-2	-1	0	1	2
Cotton seed milk (ml)	A	800	900	1000	1100	1200
Kale leaves powder (g)	B	60	70	80	90	100
Sugar (g)	C	150	175	200	225	250
Corn flour (g)	D	30	40	50	60	70

Table: 2 Coded and actual levels of the independent ingredients for fortified health drink

3.2 Optimization of Fortified Health Drink ingredients using RSM:

The independent ingredients selected for this study was Cotton seed milk, Sugar, Kale leaves powder and corn flour. A CCD contains a total of 31 experimental trials involving the replications of seven central points was used to study the linear, square and interactive effects of the four ingredients on Fortified Health Drink production based on sensory analysis properties namely colour, Aroma and taste. The design and the results based on sensory analysis for colour, Aroma and taste were given in Table 4. The student's t-test for factor coefficients and the corresponding p-values for sensory evaluation of Fortified Health Drink was given in Table 5 and Table 6. The signal of the anticipated coefficient offers the impact of the substances on response. In this way, when a factor has a positive value, the response was high at the higher level (+) and when the factor has a negative value the response was low at higher level (+). The p values were used as a tool to check the significance of each coefficient, which may in turn indicate the pattern of the interactions between the ingredients. The smaller the value of p, the corresponding coefficient was more significant. P values less than 0.05 indicates the significance of the model term.

RUN	E	P	E	P	E	P
1	6.450	6.285	6.450	6.224	6.360	6.263
2	8.938	8.992	8.573	8.938	8.938	8.992
3	7.450	7.487	7.450	7.634	7.450	7.578
4	6.450	6.577	6.450	6.548	6.450	6.543
5	9.000	8.992	9.000	8.938	9.000	8.993
6	8.323	8.524	8.323	8.575	8.323	8.506
7	7.225	7.339	7.225	7.329	7.225	7.296
8	6.653	6.775	6.653	6.765	7.326	7.174
9	7.200	7.079	7.200	6.990	7.200	6.966
10	8.053	8.030	8.666	8.430	8.358	8.197
11	7.400	7.203	7.400	7.244	7.400	7.177
12	6.200	6.134	6.200	6.263	6.200	6.290
13	7.823	7.959	8.247	8.292	8.249	8.343
14	6.944	7.170	6.944	7.118	6.944	7.112
15	8.558	8.368	8.522	8.426	8.522	8.408

16	9.000	8.992	9.000	8.938	9.000	8.992
17	5.882	5.785	6.022	5.875	6.021	5.863
18	7.950	7.808	7.950	7.854	7.950	7.947
19	7.711	7.725	7.711	7.842	7.711	7.706
20	9.000	8.991	9.000	8.939	9.000	8.991
21	9.000	8.991	9.000	8.939	9.000	8.991
22	6.080	6.225	6.080	6.184	6.080	6.286
23	6.927	7.038	6.927	7.099	6.927	7.007
24	5.661	5.750	5.685	5.725	5.685	5.678
25	8.325	8.195	8.327	8.108	8.325	8.314
26	6.450	6.445	6.450	6.486	6.450	6.564
27	9.000	8.992	9.000	8.938	9.000	8.992
28	6.663	6.498	6.665	6.646	6.700	6.704
29	6.450	6.474	6.450	6.425	6.450	6.505
30	7.200	7.153	7.200	7.110	7.280	7.148
31	9.000	8.992	9.000	8.938	9.000	8.992

Tab le 3 The responses for Fortified Health Drink production based on CCD (E-**Experimental , F- P-Predicted)**

Source	Colour			Aroma			Taste		
	Regression Coefficient	**t-statistic**	**P-value**	**Regression Coefficient**	**t-statistic**	**P-value**	**Regression Coefficient**	**t-statistic**	**P-value**
Intercept	8.99129	150.403	0.000	8.93886	116.779	0.000	9.00000	121.431	0.000
A	0.10275	3.183	0.006	0.03354	0.811	0.003	0.09379	2.343	0.002
B	0.17642	5.464	0.000	0.15563	3.765	0.002	-0.14346	-3.584	0.002
C	-0.24417	-7.563	0.000	-0.26496	-6.409	0.000	0.17488	4.369	0.000
D	-0.18783	-5.818	0.000	-0.21829	-5.281	0.000	-0.00979	-0.245	0.003
A*A	-0.20697	-6.997	0.000	-0.14522	-3.835	0.001	-0.45974	-12.537	0.000
B*B	-0.54822	-18.535	0.000	-0.53510	-14.129	0.000	-0.86486	-23.585	0.000
C*C	-0.56947	-19.253	0.002	-0.55635	-14.690	0.000	-0.37936	-10.345	0.000
D*D	-0.58234	-19.689	0.000	-0.56922	-15.030	0.000	-0.57636	-15.718	0.000
A*B	0.05375	1.359	0.000	0.08194	1.618	0.068	0.03319	0.677	0.001
A*C	0.02112	0.534	0.000	0.04931	0.974	0.003	0.30894	6.302	0.000
A*D	-0.21950	-5.551	0.000	-0.17081	-3.374	0.004	-0.17131	-3.495	0.003
B*C	0.29063	2.896	<0.011	0.00606	0.120	0.000	0.63544	12.962	0.000
B*D	-0.02812	-0.28	0.423	0.46544	9.193	0.000	-0.20731	-4.229	0.001
C*D	0.1906	1.9	0.006	0.57131	11.284	0.000	-0.63106	-12.873	0.503

Table 4 Regression coefficient and corresponding *t* and p value for sensory analysis (colour, Aroma and Taste) of fortified health drink

S = 0.158177 PRESS = 2.29160 R-Sq = 98.96% R-Sq(pred) = 94.586% R-Sq(adj) = 98.76% for color
S = 0.202577 PRESS = 3.08914 R-Sq = 98.32% R-Sq(pred) = 92.48% R-Sq(adj) = 97.82% for Aroma
S = 0.196097 PRESS =3.54382 R-Sq = 97.62% R-Sq(pred) = 94.67% R-Sq(adj) = 98.02% for taste

From Table 4, all the linear, square , interactive effects of A*D, A*C, B*C and C*D effects were found to be significant except B*D for colour. From Table 4, it was also observed that, Linear, Square, interactive effects of A*C, D*C, A*D and B*C, effects were found to be significant except A*B for Aroma. From Table 4, it was found that the linear, all the square

effects and interactive effects of A*B, A*D, A*C, B*C and B*D were significant except C*D for taste. A polynomial model was proposed for sensory analysis of processed food in the production of Fortified health drink. The three outputs, namely colour, Aroma and taste. of the product were given as polynomials in equations (1), (2)and (3) respectively.

$$Y\ (Colour) = 8.99129 + 0.10275A + 0.17642B - 0.24417C - 0.18783D - 0.20697A^2 - 0.54822B^2 - 0.56947C^2 - 0.58234D^2 + 0.05375AB + 0.02112AC - 0.21950AD + 0.29063BC - 0.02812BD + 0.19063CD \quad \ldots. (1)$$

$$Y\ (Aroma) = 8.93886 + 0.03354A + 0.15563B - 0.26496C - 0.21829D - 0.14522A^2 - 0.53510B^2 - 0.55635C^2 - 0.56922D^2 + 0.08194AB + 0.04931AC - 0.17081AD + 0.00606BC + 0.46544BD + 0.57131CD \quad \ldots.(2)$$

$$Y\ (Taste) = 9.0000 + 0.09379A - 0.14346B + 0.17488C - 0.00979D - 0.45974A^2 - 0.86486B^2 - 0.3790C^2 - 57636D^2 + 0.03319AB + 0.30894AC - 0.17131AD + 0.63544BC - 0.20731BD - 0.63106CD \quad \ldots (3)$$

3.3 ANOVA Table for sensory analysis (Color, Aroma, Taste):

Source	SOS	DF	MS	F	P
Regression	34.7425	14	2.48161	99.20	<0.000
Linear	3.2779	4	0.81947	32.76	<0.000
Square	22.8325	4	5.70813	228.17	<0.000
Interaction	8.6321	6	1.443868	57.51	<0.000
Residual Error	0.4003	16	0.02502	-	-
Lack-of-Fit	0.3971	10	0.03971	74.70	<0.000
Pure Error	0.0032	6	0.00053	-	-
Total	35.1428	30	-	-	-

Table 5 Analysis of variance (ANOVA) for sensory analysis (Color) of fortified health drink

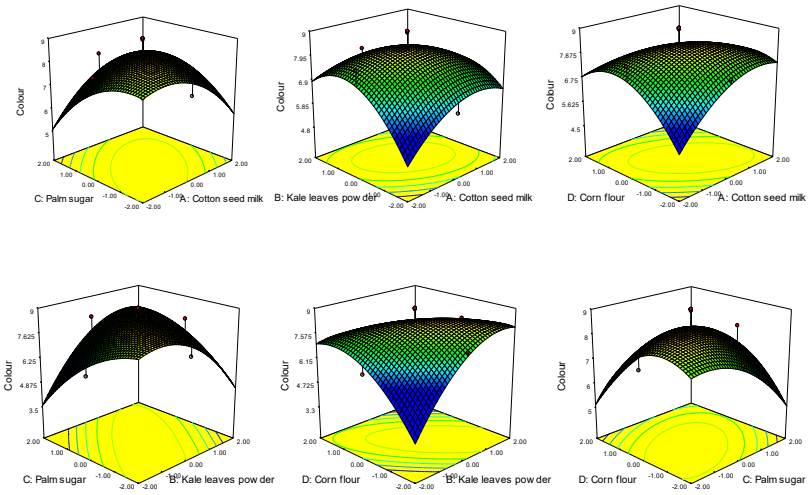
Source	SOS	DF	MS	F	P
Regression	34.4336	14	2.45955	59.97	<0.000
Linear	3.4368	4	0.85919	20.95	<0.000
Square	21.6947	4	5.42366	132.24	<0.000
Interaction	9.3022	6	1.55037	37.80	<0.000
Residual Error	0.6562	16	0.04101	-	-
Lack-of-Fit	0.4992	10	0.04992	1.91	0.040
Pure Error	0.1570	6	0.02617	-	-
Total	35.0899	30	-	-	-

Table 6 Analysis of variance (ANOVA) for sensory analysis (Aroma) of fortified health drink

Source	SOS	DF	MS	F	P
Regression	49.4913	14	3.5351	91.93	<0.000
Linear	1.4413	4	0.3603	9.37	<0.000
Square	32.5157	4	8.1289	211.40	<0.000
Interaction	15.5343	6	2.5890	67.33	<0.000
Residual Error	0.3970	16	0.6152	-	-
Lack-of-Fit	0.6152	10	0.0615	74.002	<0.000
Pure Error	0.0002	6	0.00023	-	-
Total	50.1065	30	-	-	-

Table 7 Analysis of variance (ANOVA) for sensory analysis (Taste) of fortified health drink

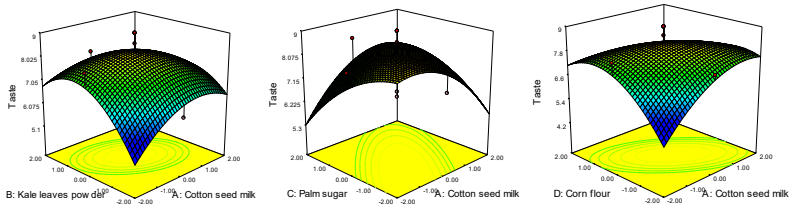
3.4 3D PLOT of Fortified Health Drink for sensory score value of colour:

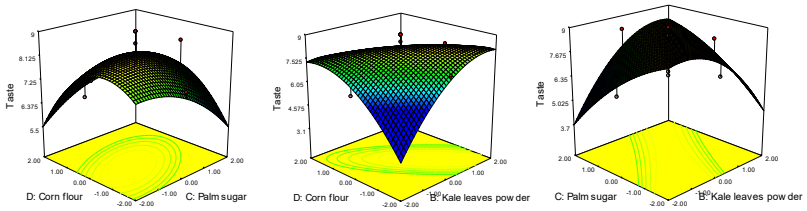


3D PLOT for sensory score value of colour

Figure 1 shows the interactive effect of Palm Sugar and Cotton seed milk composition on colour. The sensory score value of colour increases with increase in Palm Sugar and Cotton seed milk composition to about 173 g and 966g respectively and thereafter sensory score decreases with further increase in Palm Sugar and Cotton seed milk. The same trend was observed in Figure 2 which shows an increase in Cotton seed milk and Kale leaves powder composition resulted in increase in sensory score value of colour up to 966 g and 72 g respectively. Figure 3 shows the interaction effect between Palm Sugar and Corn flour for colour. The sensory score value of taste increased with increase in Cotton seed milk and Corn flour composition to about 966g and 50g respectively and sensory score decreases with further increase in Palm Sugar and Cotton seed milk composition. The same trend was observed in Figure 4 which shows an increase in Palm sugar and Kale leaves powder composition resulted in increase in sensory score value of colour up to 173g and 72g respectively. The same trend was observed in Figure 5 which shows an increase in Corn flour and Kale leaves powder composition resulted in increase in sensory score value of colour up to 50g and 72g respectively. The same trend was observed in Figure 6 which shows an increase in Palm sugar and Corn flour composition resulted in increase in sensory score value of colour up to 173g and 50g respectively.

3.5 3D PLOT of Fortified Health Drink for sensory score value of Taste:

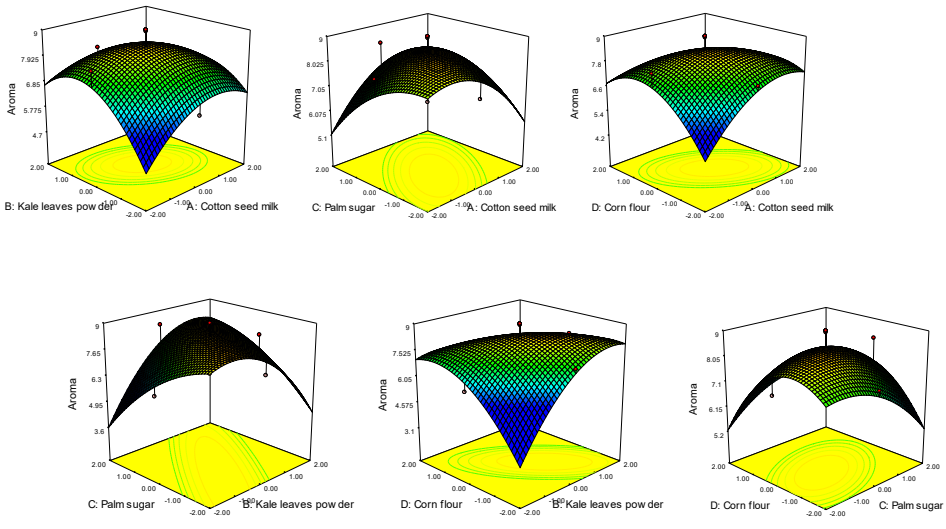




3D PLOT for sensory score value of Taste

Figure 7 depicts an increase in Kale leaves powder and Cotton seed milk resulted in increasing sensory score value of Taste up to 74g and 950g respectively. Figure 8 shows the interactive effect of Palm Sugar and Cotton seed milk composition on Taste. The sensory score value of Taste increased with increase in Palm Sugar and Cotton seed milk composition to about 173g and 950g respectively and its sensory score decreases with further increase in Palm Sugar and cotton seed milk composition. The same trend was observed in Figure 9 which shows an increase in Corn flour and Cotton seed milk composition resulted in increase in sensory score value of taste up to 52g and 950g respectively. Similarly, Figure 10, shows an increase in Corn flour and Palm sugar composition resulted in increase in sensory score value of taste up to 52g and 173g respectively. The same trend was observed in Figure 11 which shows an increase in Corn flour and Kale leaves powder composition resulted in increase in sensory score value of taste up to 52g and 74g respectively. The same trend was observed in Figure 12 which shows an increase in Corn flour and Palm sugar composition resulted in increase in sensory score value of taste up to 52g and 173g respectively.

3.6 3D PLOT of Fortified Health Drink for sensory score value of Aroma:



3D PLOT for sensory score value of Aroma

Similarly, Figure 13, shows an increase in Kale leaves powder and Cotton seed milk composition resulted in increase in sensory score value of aroma up to 73g and 955g respectively. Figure 14 shows the interactive effect of Palm Sugar and Cotton seed milk

composition for aroma. The sensory score value of aroma increased with increase in Palm Sugar and Cotton seed milk composition to about 174g and 955g respectively and further increase in Palm Sugar and Cotton seed milk composition decreased the sensory score of the aroma. The same trend was observed in Figure 15 which shows an increase in Corn flour and Cotton seed milk composition resulted in increase in sensory score value of aroma up to 51g and 955g respectively. Figure 16 shows an increase in Kale leaves powder and Palm sugar composition resulted in increase in sensory score value of aroma up to 73g and 174g respectively. Figure 17 shows an increase in Kale leaves powder and Corn flour composition resulted in increase in sensory score value of aroma up to 73g and 51g respectively. Figure 18 shows an increase in Corn flour and Palm sugar composition resulted in increase in sensory score value of aroma up to 51g and 174g respectively.

3.7 SENSORY ANALYSIS OF FORTIFIED HEALTH DRINK:

Sensory evaluation for fortified health drink was administered supported the organoleptic attributes like color, taste, aroma and texture of fortified health drink. Panelists were chosen to adopt the subsequent criteria: age 20-35 years, non-smokers, non-allergic to any food [3]. The samples were evaluated by following the nine-point hedonic scale.

NO OF PANEL MEMBERS	COLOR	AROMA	TASTE	OVERALL ACCEPTABILITY
1.	7.5	8.4	8.3	8.08
2.	7.1	8.6	8	7.98
3.	7.2	8.1	8.5	7.93

Table: 8 Sensory Analysis

3.8 NUTRITIONAL PROPERTIES OF FORTIFIED HEALTH DRINK:

S.No	Nutrients	Fortified Health Drink
1.	Energy (Kcals)	253.9
2.	Protein (gms)	26
3.	Polyunsaturated Fat (gms)	20.5
4.	Carbohydrate (gms)	41.1
5.	Dietary Fibre (gms)	13.5
6.	Vitamin C (µl/l)	2.293
7.	Vitamin A (µl/l)	2.487
8.	Vitamin K (µl/l)	2.089
9.	Omega-3 Fatty Acids (µl/l) EPA DHA	 0.3999 0.3997
10.	Omega-6 Fatty Acids (µl/l) Oleic Acid Linoleic Acid Linolenic Acid	 0.186 0.653 0.810

Table: 9 Nutritional Properties

3.9 PHYSIO - CHEMICAL PROPERTIES:

Physiochemical analysis was a method of investigating physiochemical systems that makes possible a determination of the nature of the interactions between the components of a

system through the relations between the physical properties and composition of the system. Physiochemical analysis involves the measurement of various physical properties of systems, most often phase transition temperatures and other thermal properties, electrical properties, and optical properties. In addition, measuring the density, viscosity, and hardness, as well as the dependence of the rate of the transformations occurring in a system.

MOISTURE	TSS	VISCOSITY	ACIDITY	pH	ASH
89 %	12.89degree Brix	3.1 cps	0.18 %	6.9	0.89 %

Table: 10 Physio-Chemical Properties

3.10 MICROBIAL ANALYSIS:

The maximum allowable limit of microbial growth of food product was 40-50x10^2 CFU/ml [4]. Thus, the results regarding the microbiological evaluations for Fortified Health Drink was 0.47x10^2 CFU/ml at the atmospheric condition, was observed that there was less microbial growth due to the addition of kale leaves which acts as a antimicrobial agent [5] and consumable till the end of 20 days when compared to control sample the microbial growth indicated that the sample was spoiled at the end of 15 days.

IV CONCLUSION:

The fortified Health Drink produced with Cotton seed milk and Kale Leaves powder was clearly depicted in the study. The Cotton seed milk was rich in Omega-3,6 fatty acids which were available only in sea foods. EPA and DHA deficiency was partly induced by plant-based diets, such as vegetarian diets, containing low levels of poorly bio available fatty acids. To avoid those deficiencies, we had novel the work to fortify the fatty acids in food products. The addition of Kale leaves improves the levels of vitamin A, K, C content in the fortified health drink. The optimum conditions for the best sensory score of the four outputs were obtained using Response optimizer through RSM in Minitab18. They were Cotton seed milk-970ml, Kale leaves powder-75g, Corn flour-52gand Palm sugar-178g. An experimental run was conducted by taking the Processed Ingredients that yielded best sensory value. The Fortified health drink was tested with the panelists and the scores were compared with the predicted value. The overall scores were 8.0.

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