The Pharma Innovation Journal 2022; SP-11(1): 706-709

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(1): 706-709

www.thepharmajournal.com
Received: 27-10-2021
Accepted: 09-12-2021

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Conjoint analysis for selecting the ingredients levels of energy drink

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Abstract
Conjoint analysis is a multivariate technique, which give importance to consumer preference and helps to formulate predictions about ingredients levels and it is also called as trade-off analysis. This method is a multi-attribute product concept in which consumers evaluate the utility of a product by combining separate amounts of utility provided by each level of ingredients. The energy drink was prepared with different levels of ingredients like electrolytes namely sodium (0.15 per cent, 0.20 per cent and 0.25 per cent) and potassium (0.075 per cent, 0.10 per cent and 0.125 per cent), mineral like calcium (0.025 per cent, 0.05 per cent and 0.10 per cent), caffeine (0.01 per cent, 0.02 per cent and 0.04 per cent), taurine (0.2 per cent, 0.25 per cent and 0.225 per cent) and glucuronolactone (0.06 per cent, 0.12 per cent and 0.18 per cent) with sugar (15 per cent, 10 per cent and 12 per cent). Using conjoint analysis, utility value and relative importance were determined for the attributes of the energy drink and found that it should have the following combination: Sugar – 15, $NaHCo_3$ – 0.2, KCL – 0.125, $CaCo_3$ – 0.05, Caffeine - 0.02, Taurine - 0.225 and Glucouronolactone – 0.12.

Keywords: Conjoint analysis, utility estimate, relative importance, electrolytes, attributes

1. Introduction
Energy drinks are non-alcoholic beverages which have high level of caffeine which acts as a stimulant. Energy drinks are targeted mainly for adolescent to middle-aged population as they improve performance, endurance, alertness and reduce mental fatigue. In 2020, the Asia-Pacific energy drinks market was valued at USD 13,793.02 million and it is estimated to reach a compound annual growth rate (CAGR) of 8.46% during the forecast period of 2021 to 2026. The study reported that about 68% of energy drinks consumed by young people aged 10-18 years, 30% by adult aged over 18 years and 18% by children aged under 10 years.
Energy drinks usually contain caffeine, taurine, glucuronolactone, vitamins, minerals and other supplements. Caffeine (1,3,7-trimethylxanthine) stimulate central nervous system, delays fatigue, improve alertness, concentration, vigilance performance and reduce the pain perception. Taurine (2-aminoethyl sulfonic acid) is a sulphur containing amino acid found in retina, skeletal and cardiac muscle tissue. Taurine helps in neuro modulation, cell membrane stabilization, detoxification and has anti-inflammatory property. Glucuronolactone is formed in liver and helps in improving body's defence mechanism by eliminating tumour promoters.
Whey is the nutritious liquid by-product formed during production of chhana or paneer which was the base used for preparing energy drink. Annually over 145 million tons of whey is produced worldwide and disposed as waste. Whey is considered as a pollutant with BOD value 30,000 – 50,000 mg/lit and COD of 60,000 – 80,000 mg/lit. In order to reduce the waste and utilize the whey in consumable form, there is upcoming trend for whey beverages. The whey prepared from paneer and chhana have pH between 5.3 to 5.6. Other than water, acid whey have approximately 70-72% lactose, approximately 8-10% of whey protein and approximately 12-15% minerals.
Whey is suitable for preparing energy drink because of its fresh, neural taste and better solubility. Whey based energy drink helps in hydration and also helps to maintain blood sugar level. Compared to juices, they are less acidic, refreshing and nutritious. The viscosity of energy drink is increased by whey protein and provide significant mouth feel. For energy drinks, it provide a mild flavour and also acts as a carrier of aroma compounds.
In this study, conjoint analysis was used to get best level of ingredients. It is a multivariate technique, which give importance to consumer preference and helps to formulate predictions about ingredients levels and it is also called as trade-off analysis.

This method is a multi-attribute product concept in which consumers evaluate the utility of a product by combining separate amounts of utility provided by each level of ingredients.

In conjoint analysis, selecting the attributes is the most important decision to distinguish the energy drink. If the sensory panel is provided with large number of sample combinations (3x3x3x3x3x3x3 = 2187), it create fatigue and boredom. The number of combinations can be reduced by using an Orthogonal Array Method using SPSS statistical software. The number of combinations produced by the software was 18 as shown in Table 2. Sensory analysis was done with the obtained combinations and best one was selected by running the software.

2. Materials and methods

2.1 Materials

This research work was carried out with standard materials and methods and studies were conducted at Department of Food Processing Technology, College of Food and Dairy Technology, Koduvalli, Chennai. From the standardized milk, whey was obtained using 2% citric acid. The ingredients selected for conjoint analysis were sugar, sodium, potassium, calcium, caffeine, taurine and glucuronolactone. Electrolytes and minerals were obtained from M/s. Provet Pharma, Chennai, India. Caffeine was purchased from M/s. NutriJa Lifesciences, Nagda, Madhya Pradesh, India. Taurine from M/s. ProFoods Nutrition, Maharashtra, India. Glucuronolactone from M/s, PureBulk, Roseburg, United States. The glasswares and instruments used were completely sterilized. The proximate analysis, sensory analysis, microbial analysis, vitamin and mineral analysis were carried out with standard methods. Figure 1 shows the flow chart for preparation of energy drink.

2.2 Methods

2.2.1 Design of experiment

The main aim of conjoint analysis is to determine the combination that has highest utility preferred by consumer and the relative importance of attributes are established in terms of contribution to total utility. Initially, the attributes were chosen and levels of each attribute was fixed. Table 1 shows the level of ingredients used in conjoint analysis. By an Orthogonal Array Method using SPSS statistical software, the number of combinations were determined. Then, sensory analysis was carried out and ranking was done based on higher preferences by sensory panel. Finally, the ranks were fed into the software and best one was determined.

Table 1: Level of Ingredients

S. No.	Levels	Level 1 (%)	Level 2 (%)	Level 3 (%)
1	Sugar	10	15	12
2	NaHCO3	0.25	0.20	0.15
3	KCl	0.125	0.10	0.075
4	CaCO3	0.025	0.05	0.10
5	Caffeine	0.01	0.02	0.04
6	Taurine	0.2	0.25	0.225
7	Glucuronolactone	0.06	0.12	0.18

3. Results and Discussion

The results of conjoint analysis shows the utility estimate and relative importance. The utility value represents the most preferred level that the attribute had. The relative importance represents the degree of importance that the attribute was.

Relative Importance of attribute = (Attribute Utility Range/Total Attribute Utility Range)*100

Table 2 shows the card list for energy drinks. The relative importance was represented in percentage and have property that they sum to 100. The result of conjoint analysis was given in Table 3 and shows that the Pearson's R and Kendall's tau values were 0.658 and 0.513 respectively. The conjoint analysis for selecting the best ingredient levels of ideal energy drink found that it should have the following attributes combination: Sugar – 15, $NaHCo_3$ – 0.2, KCL – 0.125, $CaCo_3$ – 0.05, Caffeine - 0.02, Taurine - 0.225 and Glucouronolactone – 0.12. Figure 2 shows the ingredients for preparation of energy drink and also product obtained.

Table 2: Card List for Energy Drink

Card ID	Sugar (%)	$NaHCO_3$ (%)	KCl (%)	$CaCO_3$ (%)	Caffeine (%)	Taurine (%)	Glucuronolactone (%)
1	12	0.15	0.125	0.025	0.02	0.250	0.12
2	8	0.25	0.125	0.025	0.01	0.20	0.06
3	12	0.20	0.125	0.10	0.01	0.20	0.18
4	10	0.25	0.125	0.05	0.04	0.25	0.18
5	12	0.25	0.10	0.05	0.04	0.20	0.12
6	8	0.15	0.10	0.05	0.01	0.25	0.06
7	10	0.15	0.125	0.10	0.04	0.225	0.06
8	12	0.20	0.10	0.025	0.04	0.225	0.06
9	8	0.25	0.10	0.10	0.02	0.225	0.18
10	8	0.20	0.075	0.025	0.04	0.25	0.18
11	12	0.15	0.075	0.05	0.01	0.225	0.18
12	10	0.25	0.075	0.025	0.01	0.225	0.12
13	8	0.15	0.075	0.10	0.04	0.20	0.12
14	12	0.25	0.075	0.10	0.02	0.25	0.06
15	10	0.20	0.075	0.05	0.02	0.20	0.06
16	8	0.20	0.125	0.05	0.02	0.225	0.12
17	10	0.20	0.10	0.10	0.01	0.25	0.12
18	10	0.15	0.10	0.025	0.02	0.20	0.18

Table 3: Conjoint analysis for quality attributes of Energy Drink

Attributes	Levels	Utility Estimate	Relative Importance (%)
Sugar	10	-1.203	23.72
	15	1.765	
	12	-.562	
$NaHCo_3$	0.25	-.616	21.75
	0.2	1.619	
	0.15	-.1.003	
KCL	0.125	.891	11.97
	0.1	-.771	
	0.075	-.220	
$CaCo_3$	0.025	-.503	16.33
	0.05	1.215	
	0.1	-.712	
Caffeine	0.01	-.575	9.47
	0.02	.705	
	0.04	-.130	
Taurine	0.2	-.421	8.53
	0.25	-.214	
	0.225	.635	
Glucoronolactone	0.06	-.301	8.22
	0.12	.612	
	0.18	-.311	
(Constant)		10.418	
Pearson's R value = 0.658**; Kendall's tau value = 0.513**			
n = 30			

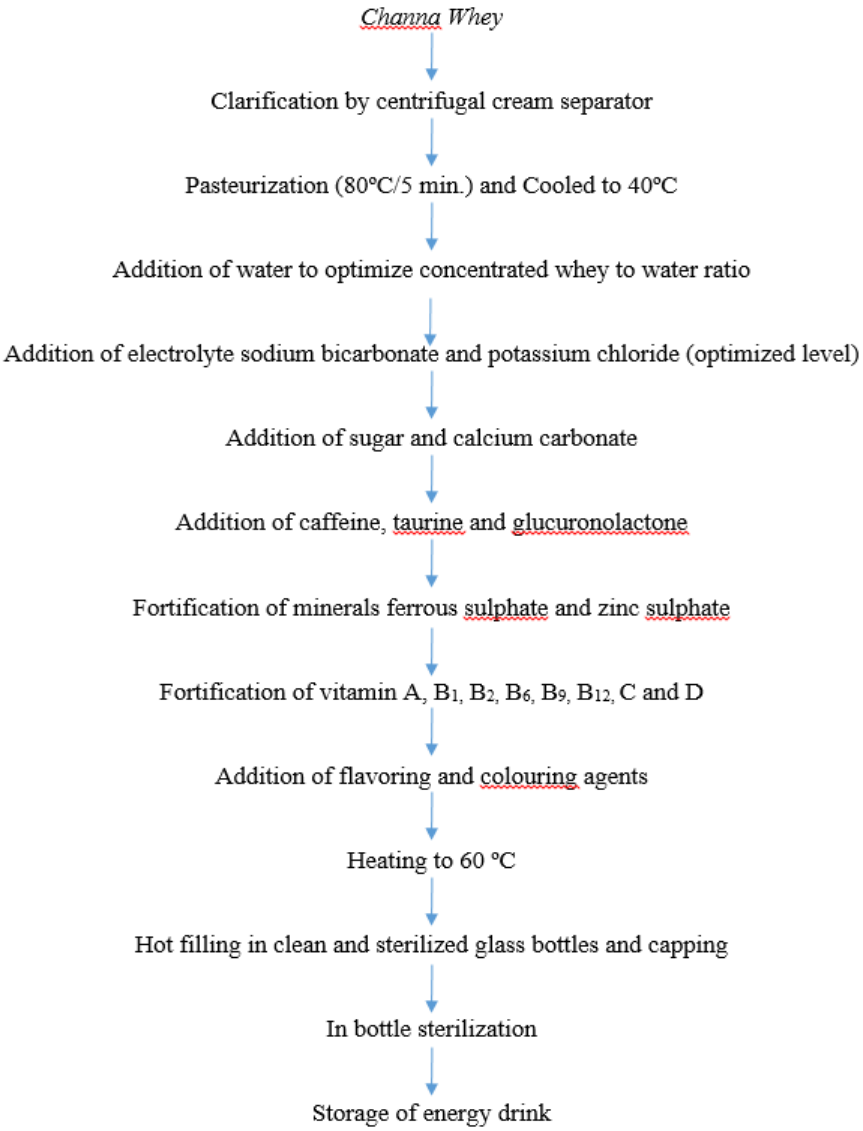
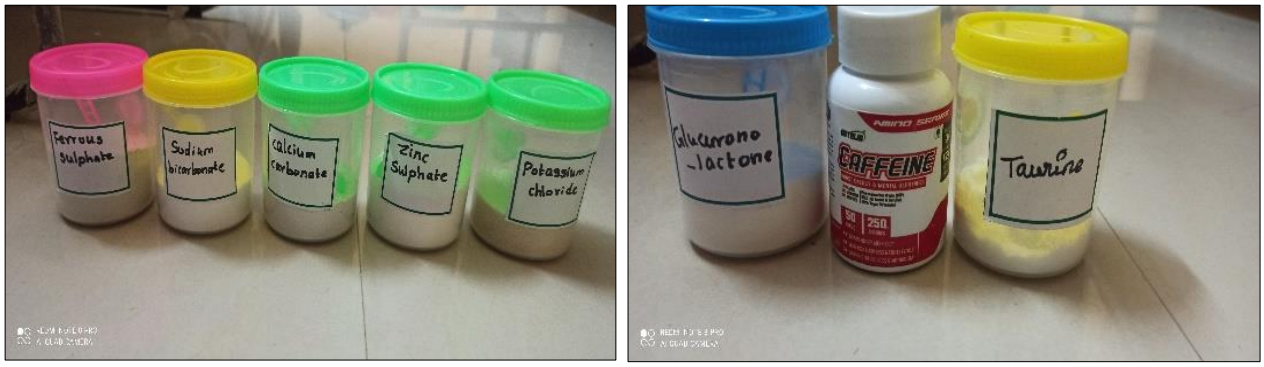


Fig 1: Flow chart for preparation of energy drink



Ingredients used for conjoint analysis

Product

Fig 2: Shows the ingredients for preparation of Energy Drink and product

4. Conclusion

Nowadays, conjoint analysis is a growing statistical method which helps the researchers to make their work feasible. It is possible to convert large number of combination into confined number of combinations. This method helps to understand the customer preference based on ingredients present in the product. Here I had developed a whey based energy drink along with stimulants which helps the consumer to regain their strength, give freshness, improve focus and alertness.

5. Acknowledgement

The authors of this article would like to acknowledge College of Food and Dairy Technology, Tamil Nadu Veterinary and Animal Sciences University, Chennai for their help and motivation throughout the research work. We also like to thank all the warm hearted persons who had their part in this research work.

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