A Mathematical Model Using Fuzzy Optimization for the Nutrient requirements of Legumes

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Abstract: - In this study we discussed about the mathematical model using the ranking of octagonal fuzzy numbers for fuzzy transportation problem and therefore the optimal solution by North west corner rule method has been employed for an excellent nutrition content for the legumes with minimum cost.

Keywords: - Fuzzy transportation problem, octagonal fuzzy number, ranking function, nutrients, legumes.

I. INTRODUCTION

Transportation problem assign with the transportation of a commodity from 'm' sources to 'n' destinations. We considered as the transportation of a altered food legumes as origins to number of vitamins as destinations.

Ranking methods map fuzzy numbers directly into the real number. Ranking function is employed in various areas of fuzzy transportation problem[1], [2], [4]. Malini and Ananthananarayanan[7], solved fuzzy assignment problem using ranking of general octagonal fuzzy numbers. Kirtiwant et.al [5] discussed about the transportation problem with generalized hexagonal and octagonal fuzzy numbers by ranking method.

Nutrition may be a methodical discipline during which food may be a major focus of interest. The definition of nutrition is analysis of what happens to food once it enters the mouth and thereafter. A proper definition of nutrition may be a process by which the breathing organs receive and utilize the assets necessary for growth, restoration and protection of body components. All the food contains some essential substances which perform important functions in our body. Nutrition researches touch food and healthy life period. Nutrient values are usually assessed using a food composition data base. Food composition information is essential when calculating the composition of menus and recipes.

In this article, we focus on commonly used legumes such as Bengal gram dal, Green gram dal, Lentil dal and Red gram dal and the composition of food supplement contributions are discussed and a method is proposed for the ranking of general octagonal fuzzy numbers. Ranking of general fuzzy numbers is employed in fuzzy transportation problem to minimize the cost of legumes. We have attained an optimal solution for the fuzzy transportation problem of minimal cost, using the fuzzy triangular membership function, by North West Corner rule, for the food stuffs that have rich vitamins with low cost .

II. PRELIMINARIES

*2.1: O*ctagonal fuzzy number

A fuzzy number $\tilde{A}_o$ is an octagonal fuzzy number denoted by $\tilde{A}_o = (a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8)$ where a_1, a_2, a_3, a_4, a_5, a_6, a_7, and a_8 are real numbers and its membership function is given below,

$$\mu_{\tilde{A}_o}(x) = \begin{cases} \frac{k(x-a_1)}{(a_2-a_1)}, & for\ a_1 \le x \le a_2 \\ k, & for\ a_2 \le x \le a_3 \\ k + (1-k)\frac{(x-a_3)}{(a_4-a_3)}, & for\ a_3 \le x \le a_4 \\ 1, & for\ a_4 \le x \le a_5 \\ k + (1-k)\frac{(a_6-x)}{(a_6-a_5)}, & for\ a_5 \le x \le a_6 \\ k, & for\ a_6 \le x \le a_7 \\ \frac{k(a_8-x)}{(a_8-a_7)}, & for\ a_7 \le x \le a_8 \end{cases}$$

Where $0 < k < 1$.

2.2: Generalized Octagonal Fuzzy number

A fuzzy number $\tilde{A}_o$ is claimed to be a generalized octagonal fuzzy number denoted by $\tilde{A}_o = (a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8; k, \omega)$ where a_1, a_2, a_3, a_4, a_5, a_6, a_7 and a_8 are real numbers and ω is its maximum membership degree, its membership function is given below

$$\mu_{\tilde{A}_o}(x) = \begin{cases} \frac{k(x-a_1)}{(a_2-a_1)}, & for a_1 \le x \le a_2 \\ k, & for a_2 \le x \le a_3 \\ k + (\omega-k)\frac{(x-a_3)}{(a_4-a_3)}, & for a_3 \le x \le a_4 \\ \omega, & for a_4 \le x \le a_5 \\ k + (\omega-k)\frac{(a_6-x)}{(a_6-a_5)}, & for a_5 \le x \le a_6 \\ k, & for a_6 \le x \le a_7 \\ \frac{k(a_8-x)}{(a_8-a_7)}, & for a_7 \le x \le a_8 \end{cases}$$

2.3 : Ranking of octagonal Fuzzy Numbers

The ranking method map fuzzy number directly into the real line. Let $\tilde{A}_o$ be a generalized octagonal fuzzy number. The ranking of $\tilde{A}_o$ is denoted by R ($\tilde{A}_o$) and it is calculated as follows:

$$R(\tilde{A}_o) = \left[\frac{3a_1 + 6a_2 + 4a_3 + 5a_4 + 5a_5 + 4a_6 + 6a_7 + 3a_8}{36}\right]$$

III. APPLICATION

Nutrition is that the procedure by which food is taken in and is consume by body. Here we consider the vitamins Niacin, Riboflavin, Thiamine, and Biotin from the legumes Bengal gram dal, Green gram dal, Lentil dal and Red gram dal. The data were collected and the amount of food supplements inthe food products were recorded, from the Nutritive rate of Indian foods given by National Institute of Nutrition [3], and food composition tables [6].

The minimum, normal and maximum content of vitamins Thiamine, Riboflavin, Niacin and Biotin in foods Bengal gram dal, Green gram dal, Lentil dal and Red gram dal is taken into account as octagonal fuzzy number. The cost per 100 mg of vitamins for every food item is taken as supply and edible portion of food stuff per 100 mg of every vitamin is taken as demand. The Nutrition content for each food item is given in Table. 3.1.

Table 3.1: Fuzzy transportation table of Nutrition content for food items

Food	Thiamine	Riboflavin	Niacin	Biotin	**Supply (cost of Edible portion of food stuff per 100 mg)**
Bengal gram dal	(0.3210,0.3293, 0.3376,0.3459, 0.3542,0.3625, 0.3708,0.3791)	(0.1470,0.1479, 0.1488,0.1497, 0.1506,0.1515, 0.1524,0.1533)	(1.8100,1.8271, 1.8442,1.8613, 1.8784,1.8955, 1.9126,1.9297)	(0.7200,0.7457, 0.7714,0.7971, 0.8228,0.8485, 0.8742,0.8999)	(0.0002, 0.0002, 0.0002, 0.0003, 0.0003, 0.0003, 0.0003, 0.0003)
Green gram dal	(0.2790,0.2993, 0.3196,0.3399, 0.3602,0.3805, 0.4008,0.4211)	(0.1040,0.1086, 0.1132,0.1178, 0.1224,0.1270, 0.1316,0.1362)	(1.6100,1.6757, 1.7414,1.8071, 1.8728,1.9385, 2.0042,2.0699)	(0.5900,0.6071, 0.6242,0.6413, 0.6584,0.6755, 0.6926,0.7097)	(0.0003, 0.0003, 0.0003, 0.0003, 0.0004, 0.0004, 0.0004, 0.0004)
Lentil dal	(0.3060,0.3157, 0.3254,0.3351, 0.3448,0.3545, 0.3642,0.3739)	(0.1550,0.1564, 0.1578,0.1592, 0.1606,0.1620, 0.1634,0.1648)	(1.7900,1.7957, 1.8014,1.8071, 1.8128,1.8185, 1.8242,1.8299)	(1.0500,1.1071, 1.1642,1.2213, 1.2784,1.3355, 1.3926,1.4497)	(0.0004, 0.0004, 0.0004, 0.0004, 0.0004, 0.0004, 0.0004, 0.0005)
Red gram dal	(0.4040,0.4171, 0.4302,0.4433, 0.4564,0.4695, 0.4826,0.4957)	(0.1040,0.1057, 0.1074,0.1091, 0.1108,0.1125, 0.1142,0.1159)	(1.9500,1.9900, 2.0300,2.0700, 2.1100,2.1500, 2.1900,2.2300)	(0.2700,0.2814, 0.2928,0.3042, 0.3156,0.3270, 0.3384,0.3498)	(0.0002, 0.0002, 0.0002, 0.0002, 0.0002, 0.0002, 0.0003, 0.0003)
Demand (cost of nutrition per 100 mg)	(0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0002, 0.0002, 0.0002)	(0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001)	(0.0007, 0.0007, 0.0007, 0.0007, 0.0008, 0.0008, 0.0008, 0.0008)	(0.0003, 0.0003, 0.0003, 0.0003, 0.0003, 0.0003, 0.0003, 0.0004)	–

Let $\tilde{A}_o$ be a generalized octagonal fuzzy number. The ranking of $\tilde{A}_o$ is denoted by R ($\tilde{A}_o$) and it is calculated as follows: $R(\tilde{A}_o) = \left[\frac{3a_1+6a_2+4a_3+5a_4+5a_5+4a_6+6a_7+3a_8}{36}\right]$

$R(\tilde{A}_o) = \frac{1}{36}[12.6036]$ =0.3501
$R(\tilde{A}_o) = \frac{1}{36}[12.6036]$ =0.3501
$R(\tilde{A}_o) = \frac{1}{36}[12.2400]$ =0.3400
$R(\tilde{A}_o) = \frac{1}{36}[16.1964]$ =0.4499
$R(\tilde{A}_o) = \frac{1}{36}[5.4072]$ =0.1502
$R(\tilde{A}_o) = \frac{1}{36}[4.3236]$ =0.1201
$R(\tilde{A}_o) = \frac{1}{36}[5.7564]$ =0.1599
$R(\tilde{A}_o) = \frac{1}{36}[3.9600]$ =0.1100

$R(\tilde{A}_o) = \frac{1}{36}[67.3164]$ =1.8699
$R(\tilde{A}_o) = \frac{1}{36}[66.2400]$ =1.8400
$R(\tilde{A}_o) = \frac{1}{36}[65.1600]$ =1.8100
$R(\tilde{A}_o) = \frac{1}{36}[75.2400]$ =2.0900
$R(\tilde{A}_o) = \frac{1}{36}[29.1888]$ =0.8108
$R(\tilde{A}_o) = \frac{1}{36}[23.3964]$ =0.6499
$R(\tilde{A}_o) = \frac{1}{36}[44.9964]$ =1.2499
$R(\tilde{A}_o) = \frac{1}{36}[11.1564]$ =0.3099

Supply

$R(\tilde{A}_o) = \frac{1}{36}[0.0108]$ =0.0003
$R(\tilde{A}_o) = \frac{1}{36}[0.0144]$ =0.0004
$R(\tilde{A}_o) = \frac{1}{36}[0.0144]$ =0.0004
$R(\tilde{A}_o) = \frac{1}{36}[0.0072]$ =0.0002

Demand

$R(\tilde{A}_o) = \frac{1}{36}[0.0036]$ =0.0001
$R(\tilde{A}_o) = \frac{1}{36}[0.0036]$ =0.0001
$R(\tilde{A}_o) = \frac{1}{36}[0.0288]$ =0.0008
$R(\tilde{A}_o) = \frac{1}{36}[0.0108]$ =0.0003

Table 3.2: Fuzzy transportation problem after applying ranking technique

Food	Thiamine	Riboflavin	Niacin	Biotin	Supply
Bengal gram dal	0.3501	0.1502	1.8699	0.8108	0.0003
Green gram dal	0.3501	0.1201	1.8400	0.6499	0.0004
Lentil dal	0.3400	0.1599	1.8100	1.2499	0.0004
Red gram dal	0.4499	0.1100	2.0900	0.3099	0.0002
Demand	0.0001	0.0001	0.0008	0.0003	0.0013

Table 3.3: Optimum solution by North West Corner method

Food	Thiamine	Riboflavin	Niacin	Biotin	Supply
Bengal gram dal	**0.0001** 0.3501	**0.0001** 0.1502	**0.0001** 1.8699	0.8108	0.0003
Green gram dal	0.3501	0.1201	**0.0004** 1.8400	0.6499	0.0004
Lentil dal	0.3400	0.1599	**0.0003** 1.8100	**0.0001** 1.2499	0.0004
Red gram dal	0.4499	0.1100	2.0900	**0.0002** 0.3099	0.0002
Demand	0.0001	0.0001	0.0008	0.0008	0.0013

The total minimum cost for nutrition food in balanced diet is

Min Z = (0.3501) (0.0001) + (0.1502) (0.0001) + (1.8699) (0.0001) + (1.8400) (0.0004) +

(1.8100) (0.0003) + (1.2499) (0.0001) + (0.3099) (0.0002)

Min Z = Rs. 0.0017 per mg per day.

IV. CONCLUSION

In this paper a way of solving fuzzy transportation problem (supply, demand and cost are all octagonal fuzzy numbers) were introduced by using ranking of fuzzy numbers. The shipping cost, availability at the origins and requirements at the destinations are all taken as octagonal fuzzy numbers to get the minimum cost of legumes. These data suggest a preservative role for suitable legumes intake to boost vitamins in a human body and also it conserves the healthy diet**.**

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