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A fuzzy mathematical model for vegetable diet plan using ranking of pentagonal fuzzy number

A. Venkatesh[1*] and A. Britto Manoj[2]

Abstract

In this research we are heading up with a method based on ranking of pentagonal fuzzy numbers in which the pattern of transportation like demand, supply and transportation cost are pentagonal fuzzy numbers. Pentagonal fuzzy numbers shows an admirable health value for the vegetables diet with minimum cost. Vogel's approximation method (VAM) in fuzzy analysis is used for attaining fuzzy transportation problem to get fuzzy minimal solution. The Vegetable diet will systematize the digestive structure and it keep us intellectually and substantially fresh.

Keywords

Pentagonal fuzzy number, Ranking function, Fuzzy transportation problem, Vegetables in human healthy diet.

AMS Subject Classification

97A40, 90B06, 90C08, 90C70, 90C90, 97M40.

[1] *Department of Mathematics, A. V. V. M. Sri Pushpam College, Poondi-613503, Tamil Nadu, India.*

[2] *Department of Mathematics, Anjalai Ammal Mahalingam Engineering College, Kovilvenni-614403, Tamil Nadu, India.*

[1] *Affiliated to Bharathidasan University, Tiruchirappalli-620024, Tamil Nadu, India.*

***Corresponding author**: [1]a_venkatesh03@yahoo.co.in; [2]brittomanoj@gmail.com

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Contents

1. Introduction

Fuzzy number of ranking is an integral system of scheming fuzzy data in optimization. The transportation problem in fuzzy gives the value of cost in generalized pentagonal fuzzy quantities. Bongju Lee and Yong Sik Yun [2] proposed the pentagonal fuzzy numbers. Jesintha Rosline and Mike Dison [5] proposed Symmetric pentagonal fuzzy numbers. Ajay Minj and Pathinathan [1] proposed ranking and similarity measures of interval-valued pentagonal fuzzy numbers. Chandrasekar, Kokila and Junu saju [3] proposed a new method for ranking exponential pentagon fuzzy numbers with using assignment problem. Selva Kumari and Santhi [7] proposed a pentagonal fuzzy number in solving fuzzy sequencing problem. Selvam, Rajkumar and Sudha Easwari [8] proposed ranking of pentagonal fuzzy numbers in applying incentre of centroids. Siji and Selva Kumari [9] proposed an approach for solving network problem with pentagonal intuitionistic fuzzy numbers using ranking technique. Thann-Lam Nguyen [10] proposed methods in ranking fuzzy numbers: a unified index and comparative reviews.

Vegetables have all the principle nutrients namely vitamins, minerals, fibers and phytochemicals that form obstruction to diseases normally. Having vegetables in our daily meal it assures immunity to the body. In weight management they insist to take more vegetables rather of oily foods and junk foods. Vegetables form a healthy diet which keeps our stomach adequate for a prolonged time. It is easy to add vegetables in our daily food. Regular consumption of vegetables ensures a young look and healthy feeling in our body.

Vegetables keep our biological cycle very regular. Bitter gourd, Snake gourd, Pumpkin, Kovakkai and Beans are the Vegetables commonly used in every home irrespective of rural and urban. Vegetables deliver all kinds of vitamins, minerals, carbohydrates, proteins, calcium, β-carotene, potassium, tannin, and iron. Vegetables diet contribute essential health for all the human being. Bitter gourd provides carotene values and vitamins which is good for eyes, skin, and internal system. Bitter gourd regulates blood sugar levels because it contains zero calorie value and with that it helps us to reduce weight.

After eating Bitter gourd, it speeds up human metabolism. Bitter gourd is loaded with many oxidative deteriorations that cover the human body against free primitive. Snake gourd is the vegetable used traditionally in our cooking. Snake gourd available in all parts of the country and it is edible fully. Snake gourd are rich in thiamine, niacin, potassium, phosphorous, calcium, and protein. Snake gourd contain vitamins and minerals. It is an outstanding cause of dietary fibre, iron, and magnesium. Snake gourd helps people to reduce their sodium intake. Pumpkin is a well-known substance in making food due to its heavy medical value. Pumpkin with a history of several thousand years of human consumption and it gives high nutritive value. It cures common cold, reduce blood pressure, and prevent from the danger of heart disease. Pumpkin food be the medicine and medicine be the food. Pumpkin contains many health benefits and it is used to prevent cancer. Kovakkai is an essential root and it is a vegetable fight with germs and illness. If we take a small part of Kovakkai daily in our food, it supports our overall health. Kovakkai lowers the imperil of cancer, diabetes, heart disease, blood sugar, muscle pain, stomach pain and joint pain. When we include kovakkai in our diet it keeps us healthy and strong. Beans is the friend of heart health. Beans help us to reduce cholesterol levels, blood clots and it boost bone density and digestive health.
In this research paper, we emphasize on vegetables considering it as essential for all human beings to have powerful nutrition impact in their life. Vegetables provide key vitamins, minerals, and fiber. Bitter gourd, snake gourd, pumpkin, kovakkai, and beans are the vegetables taken in our diet. The ranking of generalized pentagonal fuzzy number by Vogel's approximation method (VAM) is used to get minimum cost of obtaining this Vegetables diet. The endurance of this research paper is to asseverate the focus on nutrition by adopting suitable and adequate diet with lowest amount.

2. Preliminaries

Definition 2.1. *A fuzzy set $\tilde{A}$ in X is characterized by a membership function $\mu_{\tilde{A}}(x)$ which associates each point in X, to a real number in the interval $[0,1]$. The value of $\mu_{\tilde{A}}(x)$ represents grade of membership of $x \in \mu_{\tilde{A}}(x)$.*

Definition 2.2. *The α -cut of the fuzzy set $\tilde{A}$ of the universe of discourse X is defined as $\overline{A_\alpha} = \{x \in x/\mu_{\tilde{A}}(x) \geq \alpha,$ where $\alpha \in (0,1)$.*

Definition 2.3. *A fuzzy set $\tilde{A}$ is defined on the set of real numbers R is said to be a fuzzy number if its membership function $\tilde{A} : R \to [0,1]$ has the following characteristics..*

(i) $\tilde{A}$ is piecewise continuous.

(i) $\tilde{A}$ is normal that is there exists an $x \in R$ such that $\mu_{\tilde{A}}(x) = 1$.

Definition 2.4 (Pentagonal Fuzzy Number)**.** *A fuzzy number $\tilde{A}_P$ is a pentagonal fuzzy number denoted by $\tilde{A}_P = (a_1, a_2, a_3, a_4, a_5)$ where a_1, a_2, a_3, a_4, a_5 are real numbers and its membership function is given below,*

$$\mu_{\tilde{A}_p}(x) = \begin{cases} 0 & ,x < a_1 \\ \frac{(x-a_1)}{(a_2-a_1)} & ,a_1 \leq x \leq a_2 \\ \frac{1}{2}\frac{(x-a_2)}{(a_3-a_2)} & ,a_2 \leq x \leq a_3 \\ 1 & ,x = a_3 \\ \frac{a_4-x}{2(a_4-a_3)} & ,a_3 \leq x \leq a_4 \\ \frac{(a_5-x)}{(a_5-a_4)} & ,a_4 \leq x \leq a_5 \\ 0 & ,x > a_5. \end{cases}$$

3. Ranking of Pentagonal Fuzzy Number

Fuzzy number get into the real line directly by using ranking method. Let $\tilde{A}_P$ be a generalized Pentagonal fuzzy number. The ranking of $\tilde{A}_P$ is denoted by $R\left(\tilde{A}_P\right)$ and it is calculated as follows:

$$R\left(\tilde{A}_P\right) = \left[\frac{a_1 + 2a_2 + 3a_3 + 2a_4 + a_5}{9}\right].$$

4. Application

In this research paper, we progress with Vegetables such as bitter gourd, snake gourd, pumpkin, kovakkai, and beans which gives healthy supply of protein, fats, total fibre, carbohydrates, and calcium. Real data were obsessed and the measure of nutriment food in the Vegetables were listed, from the nutrition value of Indian foods given by National Institute of Nutrition [4], Indian Food Composition tables [6]. Each Vegetables are taken, and their content of protein, fats, total fibre, carbohydrates, and calcium is treated as Pentagonal fuzzy number, respectively. The cost per $100gm$ of each Vegetables is taken as supply and edible portion per $100gm$ of each Vegetables is taken as demand.
The fuzzy transportation problem for Vegetables can be formulated in the following mathematical form

$$\begin{aligned} &\text{Min}\, Z \\ &= R(1.27, 1.36, 1.45, 1.54, 1.63)a_{11} + R(0.23, 0.24, 0.25, \\ &\quad 0.26, 0.27)a_{12} + R(3.62, 3.70, 3.78, 3.86, 3.94)a_{13} \\ &+ R(2.50, 2.66, 2.82, 2.98, 3.14)a_{14} + R(18.36, 19.86, 21.36 \\ &\quad 22.86, 24.36a_{15} + R(0.65, 0.82, 0.99, 1.16, 1.33)a_{21} \\ &+ R(0.24, 0.25, 0.26, 0.27, 0.28)a_{22} + R(2.16, 2.22, 2.28, \\ &\quad 2.34, 2.40)a_{23} + R(1.12, 1.20, 1.28, 1.36, 1.44)a_{24} \\ &+ R(19.83, 22.22, 24.61, 27.00, 29.39)a_{25} + R(0.63, 0.74, \\ &\quad 0.85, 0.96, 1.07)a_{31} + R(0.14, 0.15, 0.16, 0.17, 0.18)a_{32} \end{aligned}$$

Table 1. Nutrition content for food items

Foods	Protein	Fat	Total Fibre	Carbohydrates	Calcium	Supply (cost of Edible portion of food stuff per 100 gm)
Bitter Gourd	(1.27,1.36,1.45, 1.54,1.63)	(0.23,0.24,0.25, 0.26,0.27)	(3.62,3.70,3.78, 3.86,3.94)	(2.50,2.66,2.82, 2.98,3.14)	(18.36,19.86,21.36, 22.86,24.36)	(0.46,0.48,0.50, 0.52,0.54)
Snake Gourd	(0.65,0.82,0.99, 1.16,1.33)	(0.24,0.25,0.26, 0.27,0.28)	(2.16,2.22,2.28, 2.34,2.40)	(1.12,1.20,1.28, 1.36,1.44)	(19.83,22.22,24.61, 27.00,29.39)	(0.13,0.14,0.15, 0.15,0.16)
Pumpkin	(0.63,0.74,0.85, 0.96,1.07)	(0.14,0.15,0.16, 0.17,0.18)	(2.45,2.51,2.57, 2.63,2.69)	(3.36,3.68,4.00, 4.32,4.64)	(18.76,20.91,23.06, 25.21,27.36)	(0.13,0.14,0.15, 0.16,0.17)
Kovakkai	(1.16,1.28,1.40, 1.52,1.64)	(0.16,0.20,0.24, 0.28,0.32)	(2.74,2.87,3.00, 3.13,3.26)	(1.47,1.74,2.01, 2.28,2.55)	(28.49,31.44,34.39, 37.34,40.29)	(0.11,0.12,0.12, 0.14,0.16)
Beans	(3.09,3.40,3.71, 4.02,4.33)	(0.58,0.59,0.60, 0.61,0.62)	(5.72,5.96,6.20, 6.44,6.68)	(2.53,2.69,2.85, 3.01,3.17)	(53.38,55.99,58.60, 61.21,63.82)	(0.48,0.51,0.54, 0.57,0.59)
Demand (cost of nutrition per 100 gm)	(0.26,0.28,0.31,	(0.05,0.05,0.05,	(0.61,0.63,0.65,	(0.38,0.41,0.44,	(0.00,0.01,0.01,	

$+R(2.45,2.51,2.57,2.63,2.69)a_{33}+R(3.36,3.68,4.00,$
$4.32,4.64)a_{34}+R(18.76,20.91,23.06,25.21,27.36a_{35}$
$+R(1.16,1.28,1.40,1.52,1.64)a_{41}+R(0.16,0.20,0.24,$
$0.28,0.32)a_{42}+R(2.74,2.87,3.00,3.13,3.26)a_{43}$
$+R(1.47,1.74,2.01,2.28,2.55)a_{44}+R(28.49,31.44,34.39,$
$37.34,40.29)a_{45}+R(3.09,3.40,3.71,4.02,4.33)a_{51}$
$+R(0.58,0.59,0.60,0.61,0.62)a_{52}+R(5.72,5.96,6.20,$
$6.44,6.68)a_{53}+R(2.53,2.69,2.85,3.01,3.17)a_{54}$
$+R(53.38,55.99,58.60,61.21,63.82)a_{55}$

Let $\tilde{A}_P$ be a generalized Pentagonal fuzzy number. The ranking of $\tilde{A}_P$ is denoted by $R\left(\tilde{A}_P\right)$ and it is calculated as follows:

$$R\left(\tilde{A}_P\right)=\left[\frac{a_1+2a_2+3a_3+2a_4+a_5}{9}\right]$$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[13.05]=1.45$ $R\left(\widetilde{A}_P\right)=\frac{1}{9}[36]=4.00$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[2.25]=0.25$ $R\left(\widetilde{A}_P\right)=\frac{1}{9}[207.54]=23.06$

$R\left(\tilde{A}_P\right)=\frac{1}{9}[34.02]=3.78$ $R\left(\tilde{A}_P\right)=\frac{1}{9}[12.60]=1.40$

$R\left(\tilde{A}_P\right)=\frac{1}{9}[25.38]=2.82$ $R\left(\tilde{A}_P\right)=\frac{1}{9}[2.16]=0.24$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[192.24]=21.36$ $R\left(\widetilde{A}_P\right)=\frac{1}{9}[27]=3.00$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[8.91]=0.99$ $R\left(\widetilde{A}_P\right)=\frac{1}{9}[18.09]=2.01$

$R\left(\tilde{A}_P\right)=\frac{1}{9}[2.34]=0.26$ $R\left(\tilde{A}_P\right)=\frac{1}{9}[309.51]=34.39$

$R\left(\mathring{A}_P\right)=\frac{1}{9}[20.52]=2.28$ $R\left(\mathring{A}_P\right)=\frac{1}{9}[33.39]=3.71$

$R\left(\tilde{A}_P\right)=\frac{1}{9}[11.52]=1.28$ $R\left(\tilde{A}_P\right)=\frac{1}{9}[5.40]=0.60$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[221.49]=24.61$ $R\left(\widetilde{A}_P\right)=\frac{1}{9}[55.80]=6.20$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[7.65]=0.85$ $R\left(\widetilde{A}_P\right)=\frac{1}{9}[25.65]=2.85$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[1.44]=0.16$ $R\left(\widetilde{A}_P\right)=\frac{1}{9}[527.40]=58.60$

$R\left(\mathring{A}_P\right)=\frac{1}{9}[23.13]=2.57$

Supply

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[4.50]=0.50$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[1.35]=0.15$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[1.35]=0.15$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[1.08]=0.12$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[4.86]=0.54$

Demand

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[2.79]=0.31$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[0.45]=0.05$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[5.85]=0.65$

$R\left(\widetilde{A}_P\right)=\frac{1}{9}[3.96]=0.44$

$R\left(\mathring{A}_P\right)=\frac{1}{9}[0.09]=0.01$

Table 2. Fuzzy transportation problem after applying ranking technique

Foods	Protein	Fat	Total Fibre	Carbohydrates	Calcium	Supply
Bitter Gourd	1.45	0.25	3.78	2.82	21.36	0.50
Snake Gourd	0.99	0.26	2.28	1.28	24.61	0.15
Pumpkin	0.85	0.16	2.57	4.00	23.06	0.15
Kovakkai	1.40	0.24	3.00	2.01	34.39	0.12
Beans	3.71	0.60	6.20	2.85	58.60	0.54
Demand	0.31	0.05	0.65	0.44	0.01	1.46

Table 3. Optimum solution by Vogel's approximation method

Foods	Protein		Fat		Total Fibre		Carbohydrates		Calcium		Supply
Bitter Gourd	0.16	1.45		0.25	0.33	3.78		2.82	0.01	21.36	0.50
Snake Gourd		0.99		0.26	0.15	2.28		1.28		24.61	0.15
Pumpkin	0.15	0.85		0.16		2.57		4.00		23.06	0.15
Kovakkai		1.40		0.24	0.12	3.00		2.01		34.39	0.12
Beans		3.71	0.05	0.60	0.05	6.20	0.44	2.85		58.60	0.54
Demand		0.31		0.05		0.65		0.44		0.01	1.46

Table 4. Defuzzification

Foods	Protein	Fat	Total Fibre	Carbohydrates	Calcium	Supply (cost of Edible portion of food stuff per 100 gm)
Bitter Gourd	(-0.01,0.08,0.16, 0.24,0.33) (1.27,1.36,1.45, 1.54,1.63)	(0.23,0.24,0.25, 0.26,0.27)	(0.17,0.25,0.33 0.41,0.49) (3.62,3.70,3.78, 3.86,3.94)	(2.50,2.66,2.82, 2.98,3.14)	(0.00,0.01,0.01, 0.01,0.01) (18.36,19.86,21.36, 22.86,24.36)	(0.46,0.48,0.50, 0.52,0.54)
Snake Gourd	(0.65,0.82,0.99, 1.16,1.33)	(0.24,0.25,0.26, 0.27,0.28)	(0.13,0.14,0.15, 0.15,0.16) (2.16,2.22,2.28, 2.34,2.40)	(1.12,1.20,1.28, 1.36,1.44)	(19.83,22.22,24.61, 27.00,29.39)	(0.13,0.14,0.15, 0.15,0.16)
Pumpkin	(0.13,0.14,0.15, 0.16,0.17) (0.63,0.74,0.85, 0.96,1.07)	(0.14,0.15,0.16, 0.17,0.18)	(2.45,2.51,2.57, 2.63,2.69)	(3.36,3.68,4.00, 4.32,4.64)	(18.76,20.91,23.06, 25.21,27.36)	(0.13,0.14,0.15, 0.16,0.17)
Kovakkai	(1.16,1.28,1.40, 1.52,1.64)	(0.16,0.20,0.24, 0.28,0.32)	(0.11,0.12,0.12, 0.14,0.16) (2.74,2.87,3.00, 3.13,3.26)	(1.47,1.74,2.01, 2.28,2.55)	(28.49,31.44,34.39, 37.34,40.29)	(0.11,0.12,0.12, 0.14,0.16)
Beans	(3.09,3.40,3.71, 4.02,4.33)	(0.05,0.05,0.05, 0.06,0.06) (0.58,0.59,0.60, 0.61,0.62)	(-0.42,-0.18,0.05, 0.29,0.52) (5.72,5.96,6.20, 6.44,6.68)	(0.38,0.41,0.44, 0.47,0.50) (2.53,2.69,2.85, 3.01,3.17)	(53.38,55.99,58.60, 61.21,63.82)	(0.48,0.51,0.54, 0.57,0.59)
Demand (cost of nutrition per 100 gm)	(0.26,0.28,0.31, 0.34,0.37)	(0.05,0.05,0.05, 0.06,0.06)	(0.61,0.63,0.65, 0.67,0.69)	(0.38,0.41,0.44, 0.47,0.50)	(0.00,0.01,0.01, 0.01,0.01)	

Table 5. Maximum daily vegetables diet plan for 2500 calories a day

VEGETABLES	DAILY SERV -ING SIZES IN GRAMS	COST OF SERVING IN RUPEES
Bitter Gourd	26.59	1.69
Snake Gourd	2.28	0.34
Pumpkin	0.85	0.13
Kovakkai	3.00	0.36
Beans	9.65	1.59
MAXIMUM DAILY VEGETABLES DIET COST	-	4.11

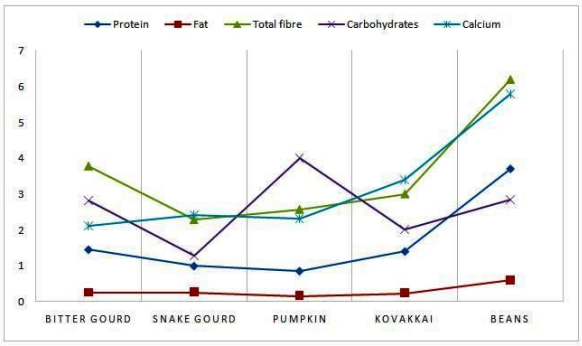

Figure 1. Nutrient content of Vegetables

The total minimum cost for vegetables is

$$\begin{aligned}\text{Min}Z =&(1.45)(0.16)+(3.78)(0.33)+(21.36)(0.01)\\&+(2.28)(0.15)+(0.85)(0.15)+(3.00)(0.12)\\&+(0.60)(0.05)+(6.20)(0.05)+(2.85)(0.44)\end{aligned}$$

$$\text{Min}Z = \text{Rs}.4.11$$

5. Conclusion

In this research paper, we observe the priority of vegetables and by applying ranking of Pentagonal fuzzy number nominal price is obtained for the diet that we are practicing daily in our life. Vegetables are clear to have ample nutrient benefits, it also provides proteins, fats, total fibre, carbohydrates, and calcium. Vegetables contain almost all the nutrients in various proportions, and it gives essential vitamins to function digestive system properly. Vegetables consumed by a large majority of population. The essential part of this paper is to show how vegetables promoting the good health of the people. This paper aimed us to cost out the diet portion of Vegetables and with the backing of transportation problem using fuzzy, we get a natural and wholesome diet.

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