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A Mathematical Model for Balanced Diet using Nonagon Fuzzy Number

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ABSTRACT

In this research we turn up with a ranking method based on nonagon fuzzy numbers in which the transportation precedent like demand, supply and transportation cost are nonagon fuzzy numbers. We carry out Vogel's approximation method in fuzzy version for finding fuzzy transportation problem to obtain fuzzy optimal solution. This method provides an accomplished nourishment of fruit diet with low cost for the normal people to stay happy, strong and healthy.

Keywords: Fuzzy transportation problem, Nonagon fuzzy number, Ranking function,human balanced diet

AMS Subject classification: 90B06, 90C08, 90C70, 90C90, 97A40, 97M40

INTRODUCTION

Fuzzy numbers in ranking plays an important role in real life. Ranking fuzzy number is a fundamentalaspect of calculating fuzzy data in optimization. The necessary association of study in ranking of generalized nonagon fuzzy number in transportation gives the value of cost in generalized nonagon fuzzy quantities. The ranking of normal fuzzy number was first suggested by Jain [3], Yager [7]. Jain and Yager also suggested the ratio which may be considered for the direction of obtaining quantities of fuzzy in [0, 1]. Felix, Christopher and Victor Devadoss [1], proposed A Nonagonal Fuzzy Number and Its Arithmetic Operation. Renuka and Jenita Nancy[5], proposed Solving a Transportation problem using Nanogonal Fuzzy Number with Robust ranking and Russell's Method.

Fruits are generally good source of vitamins and it also contains pectin which provides bulk to the diet and helps bowel movement. Every people must include fruits in their diet because fruits give so much energy and nourishment. Fruits make us healthy in all aspects and gives minimum requirement of all nutrients. The ingredient of a stabilized diet will differ according to economic status and the physiological state and also balanced diet can be distributed into three states high cost, moderate cost and low cost. Balanced diets always boost the health and wealth of the people and it also deals with digestion, consumption and

usage of fruits. People who take fruit daily as a part of their diet will have overall health and they have low risk of diseases. Fruits contain vitamins, minerals, iron and fibre. It gives not only healthy benefits but also prevent us from illness.

Banana, orange, papaya, pear and pomegranate are the fruits commonly used by the people in each part of the country because they are all wealthy source of carbohydrates, proteins, vitamins, minerals, calcium and iron. Fruits not only add variation to the diet but also provide vitamin C and vitamin A. The commonly used banana is a best source of carbohydrates and carbohydrates are the main sources of energy for doing work. Banana contains potassium and potassium is good for the health of heart. Banana helps us to digest easily and it has sources of vitamin C. Orange is high in nutrients and it helps to prevent from many diseases and it gives clear and healthy skin. Orange contains low calories.

Oranges contains antioxidants which give immunity to the human body and it helps us to prevent cancer. The fibrous content in orange makes the fruit cancer protective. Papaya normally called yellow fruit which contain β-carotene and it gives vitamin A. Papaya contains papain enzyme that is good for digestion. Papaya is high in fibre and it promotes healthy digestive system. The easy way to increase fibre intake is to eat pear. Pears are rich in nutrition and minerals. Pears contain copper and potassium and both are the important source of developing immunity in our body. Pears help us to reduce weight and improve digestion.

A pear contains iron and iron is the important part of haemoglobin. Pear is the lowest- calorie fruit. Pomegranate acts like a mask of oxygen and it fight against heart disease. Pomegranate contains heavy nutrient value that protects us from many diseases and also wealthy source of vitamins A, C and E.

In this research paper, we focus on fruits because it contains the extraordinary value of carbohydrates, proteins, vitamins, calcium, minerals and iron. Banana, orange, papaya, pear and pomegranate are the fruits taken in our diet. The ranking of generalized nonagon fuzzy number by Vogel's approximation method (VAM) [6] is used to better the amount of buying this good fruit diet. The persistence of this research paper is to illustrate the preference of health by using appropriate diet with minimum cost.

Preliminaries

Definition: (Nonagon Fuzzy Number)

A fuzzy number $\tilde{A}N$ is a nonagon fuzzy number denoted by $\tilde{A}N = (a1, a2, a3, a4, a5, a6, a7, a8, a9)$ where a1, a2, a3, a4, a5, a6, a7, a8 and a9 are real numbers and its membership function is given below,

$$\mu_{\tilde{A}_N}(x) = \begin{cases} \frac{1}{4}\frac{(x-a_1)}{(a_2-a_1)}, & for\ a_1 \le x \le a_2 \\ \frac{1}{4} + \frac{1}{4}\frac{(x-a_2)}{(a_3-a_2)}, & for\ a_2 \le x \le a_3 \\ \frac{1}{2} + \frac{1}{4}\frac{(x-a_3)}{(a_4-a_3)}, & for\ a_3 \le x \le a_4 \\ \frac{3}{4} + \frac{1}{4}\frac{(x-a_4)}{(a_5-a_4)}, & for\ a_4 \le x \le a_5 \\ 1 - \frac{1}{4}\frac{(x-a_5)}{(a_6-a_5)}, & for\ a_5 \le x \le a_6 \\ \frac{3}{4} - \frac{1}{4}\frac{(x-a_6)}{(a_7-a_6)}, & for\ a_6 \le x \le a_7 \\ \frac{1}{2} - \frac{1}{4}\frac{(x-a_7)}{(a_8-a_7)}, & for\ a_7 \le x \le a_8 \\ \frac{1}{4}\frac{(x-a_1)}{(a_2-a_1)}, & for\ a_8 \le x \le a_9 \end{cases}$$

Ranking of Nonagon Fuzzy Number

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

$$R(\tilde{A}_N) = \left[\frac{8a_1 + 4a_2 + 3a_3 + 2a_4 + 2a_5 + 2a_6 + 3a_7 + 4a_8 + 8a_9}{36}\right]$$

Application

In this paper, we take up the nourishment value of fruits such as banana, orange, papaya, pear and pomegranate which are a wealthy source of protein, fats, total fibre, carbohydrates, and calcium. Real data were collected and the amounts of nutrition food in the fruits were recorded, from the Nutritive value of Indian foods given by National Institute of Nutrition [2], Indian Food Compositiontables [4]. The lowest, natural and highest content of protein, fats, total fibre, carbohydrates and calcium in each fruit item is considered as nonagon fuzzy number respectively. The cost per 100 gm of nutritive food for each fruit item is taken as supply and edible portion per 100 gm of nutritive food for each fruit item is taken as demand.

The fuzzy transportation problem forhealthy fruits item can be formulated in thefollowing mathematical form
Min Z = R (1.15, 1.17, 1.19, 1.21, 1.23, 1.25, 1.27, 1.29, 1.31) a_{11} +R (0.32, 0.32, 0.33, 0.33, 0.33, 0.33, 0.34, 0.34, 0.34) a_{12} +R (1.87, 1.89, 1.91, 1.93, 1.95, 1.97, 1.99, 2.01, 2.03) a_{13} +R(22.89, 23.08, 23.27, 23.46, 23.65, 23.84, 4.03, 24.22, 24.41) a_{14}+R (4.13, 4.37, 4.61, 4.85, 5.09, 5.33, 5.57, 5.81, 6.05) a_{15} +R (0.58, 0.61, 0.64, 0.67, 0.70, 0.73, .76, 0.79, 0.82) a_{21}+R (0.11, 0.12, 0.12, 0.13, 0.13, 0.14, 0.14, 0.15, 0.15) a_{22} +R (1.24, 1.25, 1.26, 1.27, 1.28, 1.29, 1.30, 1.31, 1.32) a_{23} +R (7.65,7.72,7.79, 7.86,7.93,8.00,8.07,8.14,8.21) a_{24}+R

(18.04,18.41,18.78,19.15,19.52,19.89,20.26,20.63,21.00) a_{25}+R (0.37, 0.38, 039, 0.40, 0.41, 0.42, 0.43, 0.44, 0.45) a_{31}+R (0.15, 0.15, 0.16, 0.16, 0.16, 0.16, 0.17, 0.17.0.17) a_{32} +R (2.57, 2.64, 2.71, 2.78, 2.85, 2.92, 2.99, 3.06, 3.13) a_{33}+R (4.13, 4.25, 4.37, 4.49, 4.61, 4.73, 4.85, 4.97, 5.09) a_{34} +R (13.55, 13.92, 14.29, 14.66, 15.03, 15.40, 15.77, 16.14, 16.51) a_{35}+R (0.32, 0.33, 0.34, 0.35, 0.36, 0.37, 0.38, 0.39, 0.40) a_{41} +R (0.23, 0.24, 0.25, 0.26, 0.27, 0.28, 0.29, 0.30, 0.31) a_{42} + R (4.40,4.42,4.44,4.46,4.48,4.50,4.52,4.54,4.56) a_{43}+R (7.86,7.92,7.98,8.04,8.10,8.16, 8.22,8.28,8.34) a_{44} + R (5.16,5.51,5.86,6.21,6.56,6.91,7.26,7.61,7.96) a_{45}+R (1.26, 1.28, 1.30, 1.32, 1.34, 1.36, 1.38,

1.40, 1.42) a_{51}+R (0.13, 0.14, 0.14, 0.15, 0.15, 0.16, 0.16, 0.17, 0.17) a_{52}+R (2.77, 2.79, 2.81, 2.83, 2.85, 2.87, 2.89, 2.91, 2.93) a_{53}+R (11.15, 11.26, 11.37, 11.48, 11.59, 11.70, 11.81, 11.92, 12.03) a_{54}+R (8.83, 9.29, 9.75, 10.21, 10.67, 11.13, 11.59, 12.05, 12.51) a_{55}.

Table.4.1 Nutrition content for food items

Foods	Protein	Fat	Total Fibre	Carbo-hydrates	Calcium	Supply (cost of Edible portion of food stuff per 100 gm)
Banana	(1.15,1.17,1.19, 1.21,1.23,1.25, 1.27,1.29,1.31)	(0.32, 0.32,0.33, 0.33,0.33,0.33, 0.34,0.34,0.34)	(1.87,1.89,1.91, 1.93,1.95,1.97, 1.99,2.01,2.03)	(22.89,23.08,23.27, 23.46,23.65,23.84, 24.03,24.22,24.41)	(4.13,4.37,4.61, 4.85,5.09,5.33, 5.57,5.81,6.05)	(1.05,1.06,1.07, 1.08,1.09,1.10, 1.11,1.11,1.12)
Orange	(0.58,0.61,0.64, 0.67,0.70,0.73, 0.76,0.79,0.82)	(0.11, 0.12,0.12, 0.13,0.13,0.14, 0.14,0.15,0.15)	(1.24,1.25,1.26, 1.27,1.28,1.29, 1.30,1.31,1.32)	(7.65,7.72,7.79 7.86,7.93,8.00, 8.07,8.14,8.21)	(18.04,18.41,18.78, 19.15,19.52,19.89, 20.26,20.63,21.00)	(0.77,0.78,0.79, 0.80,0.80,0.81, 0.82,0.83,0.84)
Papaya	(0.37,0.38,039, 0.40,0.41,0.42, 0.43,0.44,0.45)	(0.15, 0.15,0.16, 0.16,0.16,0.16, 0.17,0.17.0.17)	(2.57,2.64,2.71, 2.78,2.85,2.92, 2.99,3.06,3.13)	(4.13,4.25,4.37, 4.49,4.61,4.73, 4.85,4.97,5.09)	(13.55,13.92,14.29, 14.66,15.03,15.40, 15.77,16.14,16.51)	(0.43,0.45,0.46, 0.47,0.48,0.49, 0.51,0.52,0.53)

Pear	(0.32,0.33,0.34, 0.35,0.36,0.37, 0.38,0.39,0.40)	(0.23, 0.24,0.25, 0.26,0.27,0.28, 0.29,0.30,0.31)	(4.40,4.42,4.44, 4.46,4.48,4.50, 4.52,4.54,4.56)	(7.86,7.92,7.98, 8.04,8.10,8.16, 8.22,8.28,8.34)	(5.16,5.51,5.86, 6.21,6.56,6.91, 7.26,7.61,7.96)	(0.90,0.90,0.91, 0.92,093,093, 0.94,0.95,0.95)
Pomegranate	(1.26,1.28,1.30, 1.32,1.34,1.36, 1.38,1.40,1.42)	(0.13, 0.14,0.14, 0.15,0.15,0.16, 0.16,0.17,0.17)	(2.77,2.79,2.81, 2.83,2.85,2.87, 2.89,2.91,2.93)	(11.15,11.26,11.37, 11.48,11.59,11.70, 11.81,11.92,12.03)	(8.83,9.29,9.75, 10.21,10.67,11.13, 11.59,12.05,12.51)	(2.45,2.48,2.50, 2.53,2.55,2.58 2.60,2.63,2.65)
Demand (cost of nutrition per 100 gm)	(0.34,0.35,0.35, 0.36,0.37,0.38, 0.38,0.39,0.40)	(0.07,0.07,0.07, 0.08,0.08,0.08, 0.08,0.08,0.08)	(1.08,1.09,1.10, 1.11,1.12,1.13, 1.14,1.15,1.16)	(4.11,4.15,4.19, 4.24,4.28,4.32, 4.36,4.41,4.45)	(0.00,0.00,0.00, 0.00,0.00,0.00, 0.01,0.01,0.01)	

Let $\tilde{A}N$ be a generalized nonagon fuzzy number. The ranking of $\tilde{A}N$ is denoted by R ($\tilde{A}N$)

and it is calculated as follows: $R(\tilde{A}N) = \frac{[8a1+4a2+3a3+2a4+2a5+2a6+3a7+4a8+8a9]}{36}$

$R(\tilde{A}N) = \frac{1}{36}[44.28] = 1.23$	$R(\tilde{A}N) = \frac{1}{36}[161.28] = 4.48$	**Supply**
$R(\tilde{A}N) = \frac{1}{36}[25.20] = 0.70$	$R(\tilde{A}N) = \frac{1}{36}[102.60] = 2.85$	$R(\tilde{A}N) = \frac{1}{36}[39.24] = 1.09$
$R(\tilde{A}N) = \frac{1}{36}[14.76] = 0.41$	$R(\tilde{A}N) = \frac{1}{36}[851.40] = 23.65$	$R(\tilde{A}N) = \frac{1}{36}[28.8] = 0.80$
$R(\tilde{A}N) = \frac{1}{36}[12.96] = 0.36$	$R(\tilde{A}N) = \frac{1}{36}[285.48] = 7.93$	$R(\tilde{A}N) = \frac{1}{36}[17.28] = 0.48$
$R(\tilde{A}N) = \frac{1}{36}[48.24] = 1.34$	$R(\tilde{A}N) = \frac{1}{36}[165.96] = 4.61$	$R(\tilde{A}N) = \frac{1}{36}[33.48] = 0.93$
$R(\tilde{A}N) = \frac{1}{36}[11.88] = 0.33$	$R(\tilde{A}N) = \frac{1}{36}[291.60] = 8.10$	$R(\tilde{A}N) = \frac{1}{36}[91.80] = 2.55$
$R(\tilde{A}N) = \frac{1}{36}[4.68] = 0.13$	$R(\tilde{A}N) = \frac{1}{36}[417.24] = 11.59$	

$R(\tilde{A}_N) = \frac{1}{36}[5.76] = 0.16$	$R(\tilde{A}_N) = \frac{1}{36}[183.24] = 5.09$	**Demand**
$R(\tilde{A}_N) = \frac{1}{36}[9.72] = 0.27$	$R(\tilde{A}_N) = \frac{1}{36}[702.72] = 19.52$	$R(\tilde{A}_N) = \frac{1}{36}[13.32] = 0.37$
$R(\tilde{A}_N) = \frac{1}{36}[5.40] = 0.15$	$R(\tilde{A}_N) = \frac{1}{36}[541.08] = 15.03$	$R(\tilde{A}_N) = \frac{1}{36}[2.88] = 0.08$
$R(\tilde{A}_N) = \frac{1}{36}[70.20] = 1.95$	$R(\tilde{A}_N) = \frac{1}{36}[236.16] = 6.56$	$R(\tilde{A}_N) = \frac{1}{36}[40.32] = 1.12$
$R(\tilde{A}_N) = \frac{1}{36}[46.08] = 1.28$	$R(\tilde{A}_N) = \frac{1}{36}[384.12] = 10.67$	$R(\tilde{A}_N) = \frac{1}{36}[154.08] = 4.28$
$R(\tilde{A}_N) = \frac{1}{36}[102.6] = 2.85$		$R(\tilde{A}_N) = \frac{1}{36}[0.15] = 0.00$

Table 4.2: Fuzzy transportation problem after applying ranking technique

Foods	Protein	Fat	Total Fibre	Carbohydrates	Calcium	Supply
Banana	1.23	0.33	1.95	23.65	5.09	1.09
Orange	0.70	0.13	1.28	7.93	19.52	0.80
Papaya	0.41	0.16	2.85	4.61	15.03	0.48
Pear	0.36	0.27	4.48	8.10	6.56	0.93
Pomegranate	1.34	0.15	2.85	11.59	10.67	2.55
Demand	0.37	0.08	1.12	4.28	0.00	5.85

Table 4.3: Optimum solution by Vogel's Approximation method

Foods	Protein	Fat	Total Fibre	Carbohydrates	Calcium	Supply
Banana	1.23	0.33	**1.09** 1.95	23.65	5.09	1.09
Orange	0.70	0.13	1.28	**0.80** 7.93	19.52	0.80
Papaya	0.41	0.16	2.85	**0.48** 4.61	15.03	0.48
Pear	**0.37** 0.36	0.27	4.48	**0.56** 8.10	6.56	0.93
Pomegranate	1.34	**0.08** 0.15	**0.03** 2.85	**2.44** 11.59	**0.00** 10.67	2.55
Demand	0.37	0.08	1.12	4.28	0.00	5.85

Table 4.4: Defuzzification

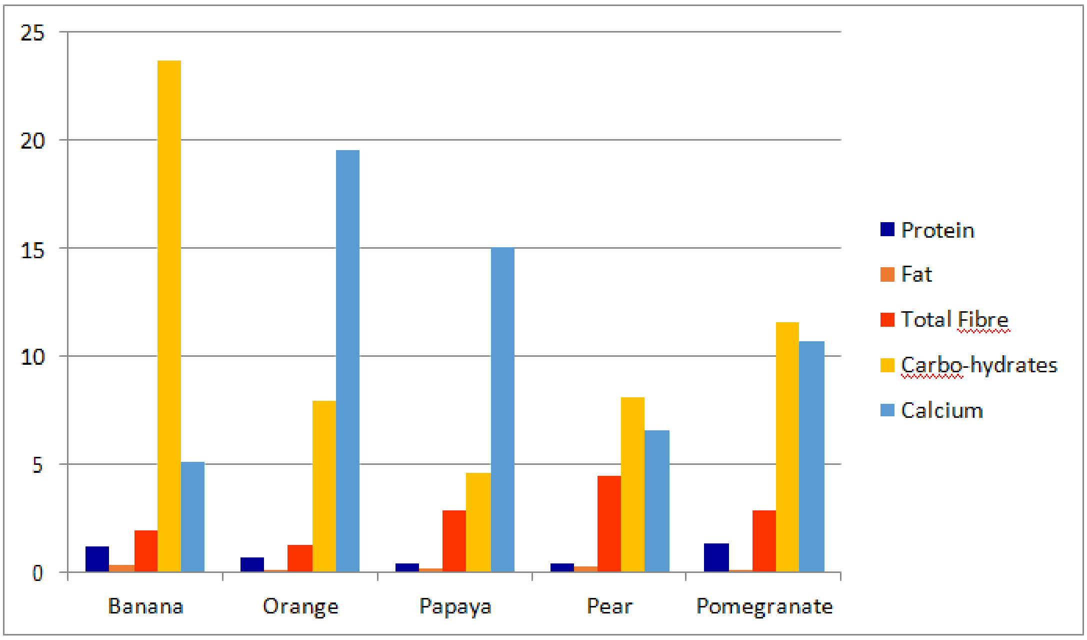
Foods	Protein	Fat	Total Fibre	Carbo-hydrates	Calcium	Supply (cost of Edible portion of food stuff per 100 gm)
Banana	(1.15,1.17, 1.19, 1.21,1.23, 1.25, 1.27,1.29, 1.31)	(0.32,0.32,0.33, 0.33,0.33,0.33, 0.34,0.34,0.34)	**(1.05,1.06,1.07, 1.08,1 .09, 1.10,1.11,1.11, 1.12)** (1.87,1.89,1.91, 1.93,1.95,1.97, 1.99,2.01,2.03)	(22.89,23.08, 23.27, 23.46,23.65, 23.84, 24.03,24.22, 24.41)	(4.13,4.37,4.61, 4.85,5.09,5.33, 5.57,5.81,6.05)	(1.05,1.06,1.07, 1.08,1.09,1.10, 1.11,1.11,1.12)
Orange	(0.58,0.61, 0.64, 0.67,0.70, 0.73, 0.76,0.79, 0.82)	(0.11,0.12,0.12, 0.13,0.13,0.14, 0.14,0.15,0.15)	(1.24,1.25,1.26, 1.27,1.28,1.29, 1.30,1.31,1.32)	**(0.77,0.78,0.79,0.80,0 .80, 0.81,0.82,083 0.84)** (7.65,7.72,7.79 7.86,7.93,8.00, 8.07,8.14,8.21)	(18.04,18.41,18.78, 19.15,19.52,19.89, 20.26,20.63,21.00)	(0.77,0.78,0.79, 0.80,0.80,0.81, 0.82,0.83,0.84)
Papaya	(0.37,0.38, 039, 0.40,0.41, 0.42, 0.43,0.44, 0.45)	(0.15,0.15,0.16, 0.16,0.16,0.16, 0.17,0.17.0.17)	(2.57,2.64,2.71, 2.78,2.85,2.92, 2.99,3.06,3.13)	**(0.43,0.45,0.46,0.47,0 .48, 0.49,0.51,0.52,0.53)** (4.13,4.25,4.37, 4.49,4.61,4.73, 4.85,4.97,5.09)	(13.55,13.92,14.29, 14.66,15.03,15.40, 15.77,16.14,16.51)	(0.43,0.45,0.46, 0.47,0.48,0.49, 0.51,0.52,0.53)
Pear	**(0.34,0.35,0.35,0.36,0 .37, 0.38,0.38,0.39,0.40)**	(0.23,0.24,0.25, 0.26,0.27,0.28, 0.29,0.30,0.31)	(4.40,4.42,4.44, 4.46,4.48,4.50, 4.52,4.54,4.56)	**(0.33,0.39,0.45,0.51,0 .57, 0.63,0.69,0.75,0.81)**	(5.16,5.51,5.86, 6.21,6.56,6.91, 7.26,7.61,7.96)	(0.90,0.90,0.91, 0.92,093,093, 0.94,0.95,0.95)
	(0.32,0.33,0.34, 0.35,0.36,0.37, 0.38,0.39,0.4			**(7.86,7.92,7.98, 8.04,8.10,8.16, 8.22,8.28,8.3**		

	0)			**4)**		
Pomegranate	**(1.26,1.28,1.30, 1.32,1.34,1.36, 1.38,1.40,1.42)**	(0.07,0.07,0.07,0.08,0.08, 0.08,0.08,0.08,0.08) (0.13,0.14,0.14, 0.15,0.15,0.16, 0.16,0.17,0.17)	(-0.33,-0.01,0.01,0.03, 0.05,0.07,0.09,0.11,0.13) (2.77,2.79,2.81, 2.83,2.85,2.87, 2.89,2.91,2.93)	**(2.01,2.12,2.23,2.34,2.45, 2.56,2.67,2.78,2.89) (11.15,11.26, 11.37, 11.48,11.59,11.70, 11.81,11.92,12.03)**	(0.00,0.00,0.00,0.00,0.00, 0.00,0.01,0.01,0.01) (8.83,9.29,9.75, 10.21,10.67,11.13, 11.59,12.05,12.51)	(2.45,2.48,2.50, 2.53,2.55,2.58, 2.60,2.63,2.65)
Demand (cost of nutrition per 100 gm)	**(0.34,0.35,0.35, 0.36,0.37,0.38, 0.38,0.39,0.40)**	(0.07,0.07,0.07, 0.08,0.08,0.08, 0.08,0.08,0.08)	(1.08,1.09,1.10, 1.11,1.12,1.13, 1.14,1.15,1.16)	**(4.11,4.15,4.19, 4.24,4.28,4.32, 4.36,4.41,4.45)**	(0.00,0.00,0.00, 0.00,0.00,0.00, 0.01,0.01,0.01)	

The total minimum cost for nourishment is
Min Z = (1.95) (1.09) + (7.93) (0.80) + (4.61) (0.48) + (0.36) (0.37) + (8.10) (0.56) + (0.15) (0.08) + (2.85) (0.03) + (11.59) (2.44) + (10.67) (0.00)Min
Z = Rs.43.73

Optimal daily fruit diet plan for 2,500 calories a day

Fruits	Daily Serving Sizes In Grams	Cost Of Serving In Rupees
Banana	1.95	2.13
Orange	7.93	6.34
Papaya	4.61	2.21
Pear	8.46	4.67
Pomegranate	25.26	28.38
Optimal Daily Fruit Diet Cost	-	43.73



CONCLUSION

By using ranking of generalized nonagon fuzzy number minimum amount is attained for the fruits. To prepare people active and fresh a fruit plays a major role. The food combination what we discussed in this paper is commonly used in all parts of India because fruits are the essential source of proteins, vitamins, minerals, calcium and iron. The main aim of this paper is to create awareness about fruits to the people because fruits are low in calories and high in fibre. Fruits play a major role in diet and it can help people to control their weight. This paper encouraged us to cost out the diet segment of fruits and with the help of fuzzy transportation problem we get a worthy and healthy diet.

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