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Selection of Best Method for The Formulation of Orodispersible Tablets by Applying Fuzzy Analytic Hierarchy Process

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ABSTRACT

Recent developments in the technology have initiated scientists to develop orally disintegrating tablets (or) orodispersible tablets with an improved patient compliance and convenience. There are various methods available for the formulation of orodispersible tablets like direct compression, lyophilization (or) freeze drying, sublimation and vaccum drying etc. It is important to incorporate all the quantitative and qualitative criteria such as formulation information, manufacturing skill, supplier, technical information, technical status and machine in the selection process. The fuzzy set theory allows to incorporate unquantifiable, incomplete and partially known information into the decision model. Hence, in the present study fuzzy analytic hierarchical process (FAHP) was applied to select best method for the formulation of orodispersible tablets. Based on the results of FAHP it is concluded that direct compression method is the best method for the formulation of orodispersible tablets.

Keywords: Orodispersible tablets, Selection of best method, Fuzzy analytic hierarchy process

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INTRODUCTION

Most pharmaceutical dosage forms administered orally are formulated to be swallowed or chewed in order to deliver the drug but pediatric, geriatric and mentally ill patients may have difficulties in swallowing or chewing these tablets. To overcome this problem in recent years it attracted the interest of many researchers to develop innovative drug delivery system known as orodispersible tablets (ODTs) or mouth dissolving tablets (MDTs). The basic approach used in the development of ODTs is the use of superdisintegrants and another approach used in developing such tablets is maximizing pore structure of tablets. The developments of ODTs are broadly classified into two major categories namely, conventional and patented technology [24].

The selection criteria for this formulation method, the overall goal is to achieve convenient method to develop ODTs with taste and texture acceptable to patients with sufficient structural integrity with low cost. This is influenced by various factors such as formulation information of the equipment and method, manufacturing skill of the formulator, knowledge of the equipment and availability of the equipment supplier, servicing, spares and vendor status. Hence, while choosing the technique, consideration of cost factor alone may not be justifiable. It is more rational and appropriate to analyze both qualitative and quantitative parameters for a final decision. When two or more alternatives are in hand and one has to select the best, then the appropriate approach is to use multi criteria decision making (MCDM) method. It is an important to incorporate all the factors that could influence making orodispersible tablets in decision making process by choosing a method.

The present study was aimed on fuzzy analytic hierarchy process (FAHP) as a tool to select the best method among the various method such as direct compression (DCP), sublimation (SUB), lyophilization or freeze-drying (LYN) and vacuum drying (VCD) for the formulation of ODTs.

There are two problems in the selection of best method for ODTs. First, the criteria for evaluation are generally multiple and in conflict. For an example, production condition can be very efficient in method selection which is very expensive to apply for some methods. Such production condition is highly valued based on benefit criterion but low valued on cost criteria. In second, accommodation of high dose and friability of both the criteria and production condition can be result of imprecise subjective judgments or incomplete objective information. The first problem can be solved by the use of multiple criteria decision making techniques. However, the second problem involves uncertainty in measurements and preferences that cannot be properly solved without the application of fuzzy set theory.

The analytical hierarchy process (AHP) developed by Saaty scale is a decision approach designed to be used in the solution of complex multiple criteria decision problems and has been used in a wide variety of application. This method models a complex decision problem into a hierarchy descending from an overall objective at the top to various criteria and the decision alternatives at the lowest level and pair wise comparison are used to determine the relative importance among the criteria with global weights calculated for each matrix. However, in this approach both pair wise comparison ratios and the resulting weights are specific real numbers [1]. The problem of imprecise subjective judgments and incomplete information is not sufficient to select the best method.

Fuzzy set theory is an useful tool for solving the above problem. The fuzzy set theory is body of concepts and techniques that gave a norm mathematical precision to human cognitive process which in many ways are imprecise and ambiguous by the standards of classical mathematics. In the fuzzy set theory of concept and techniques [3]. AHP for instance uses a 1 to 9 real number scale to describe the relative importance between criteria or alternative with respect to a criterion. Since the concept of relative importance such as strong importance is linguistically ambiguous, triangular fuzzy 1 to 9 scale can be used to represent the fuzziness in criterion definitions as well as the uncertainty in subjective judgments and incomplete objective information. So fuzzy multiple criteria decision making techniques is very useful tool for the selection of best method for ODTs tablets.

A FUZZY AHP APPROACH

The AHP is a theory for discussing with complex technological, economic and socio-political problems [4, 5]. Basically, the AHP is a multi objective criteria decision making approach that employs a pair wise comparison procedure to arrive at a scale of preferences among a set of alternatives. For this approach, it is necessary to breakdown a complex unstructured problem into its component parts arrange these variables into a hierarchic order, assign numerical values to our judgments on the relative importance of each variables and find out the judgment to determine which variables have the highest priority and should be acted up on to influence the outcome. The break down involves structuring the problem as a hierarchy, which is used to understand each part within its appropriate context.

The fig:2 shows, a typical FAHP model consists of at least four hierarchical level. The top level explain the overall objective of analysis. In this case to select the best method for the formulation of ODTs tablets. The second level includes all relevant and important evaluation criteria (in our study, Formulation information, Manufacture skill, Technical information, Technical status and Machine) that influence the overall objective. The third level sub criteria is identified and structured into a hierarchy descending from the overall objective. The matrix derived from the pair wise comparison using a Saaty's or nine point scale is called judgment matrix [6]. By using triangular fuzzy method from judgment matrix, normalization value is calculated from weight vectors, the sum of normalization value gives for attributes gives the choice of selection of best method for the formulation of ODTs tablets.

Many decision making and problem solving tasks are too complex to be understood quantitatively, however many of them succeed by using knowledge that is imprecise rather than precise. Fuzzy set theory resembles human reasoning in its use of approximate information and uncertainty to generate decisions. It was specifically designed to mathematically represent uncertainty and vagueness and provide formalized tools for dealing with the imprecision intrinsic to many problems.

IDENTIFICATION OF PROBLEM TO SELECT THE BEST METHOD

This section presents a problem concerns for the methods of ODTs tablets and their selection of the type of best method. This selection is an important criteria to come out with best formulation and improved patients compliance.Here, according the literature to make the necessary judgments to be used in a FAHP analysis of this decision problem.

The first stage was the identification of the necessary criteria to be considered, here was a consequence of a semi-structured based on the literature. Following discussion with the literature concerning the nature of the application, it was decided to restrict the number of criteria into six areas namely, formulation information, manufacture skill, supplier, technical information, technical status and machine (hereafter C_1, C_2, C_3, C_4, C_5 and C_6) with sub criteria for C_1 as Production Scale C_1^1(PS), Production Condition C_2^1 (PC), C_2 as Method C_1^2(ME), Knowledge C_2^2 (KN), Training C_3^2(TR), C_3 as Availability C_1^3(AV), Experience C_2^3 (EX), Service C_3^3 (SE), Spares C_4^3(SP), Monopoly C_5^3(MO), C_4 as Manual C_1^4(MA), Literature C_2^4(LT), C_5 as established method C_1^5(EM), Growth C_2^5 (GR) and C_6 as Versatility C_1^6(VE), Complexity C_2^6(CO) respectively.

Apart from the six criteria, the initial problem was identified for four types of methods, which are most commonly used for the formulation of ODTs tablets. Such as direct compression (DCP), sublimation (SUB), lyophilization or freeze-drying (LYN) (U.S.Patent No: 5807576: U.S.Patent No: 5587180) and vacuum drying (VCD) (hereafter M_1, M_2, M_3 and M_4). These are the decision alternatives (DAs) in this case study. Given the necessary details of the criteria and DAs, based on the literature to indicate preferences between pairs of criteria and then between pairs of alternatives over the different criteria through the structured and the linguistic variables used to make the pair wise comparisons were those associated with the standard 9-unit scale.

PRESENTATION OF THE SYNTHETIC EXTENT FAHP METHOD

In this study the modified synthetic extent FAHP is utilised, which was initially introduced [20], developed [22], and in recent times applied to the selection of computer integrated manufacturing systems [7]. One reason for its service is that it allows for incompleteness of the pair wise judgments made, though it is not the only FAHP approach to allow this [8]. This feature reflects its suitability in decision problems where uncertainty exists in the judgment-making process.

A brief description about addition, multiplication and division of triangular number is given below. Let *A* and *B* be two triangular fuzzy numbers, with their parameters as follows:

$\tilde{A} = (a_1 a_2, a_3)$
$\tilde{B} = (b_1 b_2, b_3)$
Fuzzy number addition is defined as
$\tilde{A} \oplus \tilde{B} = (a_1 + b_1, a_2 + b_2, a_3 + b_3)$ (1)
Then, fuzzy numbers multiplication is defined by
$\tilde{A} * \tilde{B} = (a_1 * b_1, a_2 * b_2, a_3 * b_3)$ (2)
On the other hand, fuzzy numbers division is defined as follows:
$\tilde{A} / \tilde{B} = (a_1/b_3, a_2/b_2, a_3/b_1)$ (3)

Whilst the reciprocal value of a triangular fuzzy number (a, b, c) is given by (1/a, 1/b, 1/c). The power of a triangular fuzzy number is given by (Chiu, C. Y., Park, C. S., 1994; Orlando Duran., José Aguilo., 2008)
$\tilde{A}^n = (a_1 a_2, a_3)^n = (a^n{}_1, b^n{}_2, c^n{}_3)$ (4)

Triangular fuzzy numbers (TFNs)

Table:1

Characteristic function of the fuzzy numbers

Fuzzy number		Characteristic (membership) function
$\tilde{1}$	=	(1, 1,3)
$\tilde{2}$	=	(1, 2, 4)
$\tilde{x}$	=	(x-2, x, x+2) for x = 3, 4, 5, 6, 7, 8 [11]

The most widely used practical application accurately explained by geometric mean. Here, geometric mean used as the model for triangular fuzzy number. The fuzzy set theory introduced to discuss with the uncertainty due to imprecision and vagueness. A major involment of fuzzy set theory was its capability of representing vague data [12]. It is often convenient to work with TFNs in this application because of their computational simplicity [13], and they are useful in promoting representation and information processing in a fuzzy environment [14] In addition, TFNs are the most utilized in FAHP studies [15, 16]. TFNs can be defined by a triplet *(l, m, u)* and the membership function can be defined by equation (5) [2]:

$$\mu_A(X) = \begin{pmatrix} 0 & x < l; \\ \dfrac{x-l}{m-l} & l \le x \le m; \\ \dfrac{m-x}{u-m} & m \le x \le m \\ 0 & x < l; \end{pmatrix} \qquad (5)$$

Construction of the FAHP comparison matrices

The objective of any FAHP method is to explain an order of preference on a number of DAs, i.e., a prioritised ranking of DAs. Central to this method is a series of pair wise comparisons, representing the relative preferences between pairs of DAs in the same hierarchy. It is difficult to map qualitative preferences to point estimates, and hence a degree of uncertainty is associated with some or all pair wise comparison values in an FAHP problem [23]. Using triangular fuzzy numbers with the pair wise comparisons made, the fuzzy comparison matrix $X = (x_{ij})_{n \times m}$ is constructed.

The pair wise comparisons are described by values taken from a pre-defined set of ratio scale values as presented in Saaty Scale. The ratio comparison between the relative preference of elements indexed i and j on a criterion can be modeled through a fuzzy scale value associated with a degree of fuzziness. Then an element of X, x_{ij} (i.e., a comparison of the ith DA with the jth DA with respect to a specific criterion) is a fuzzy number, defined as $x_{ij} = (l_{ij}, m_{ij}, u_{ij})$, where m_{ij}, u_{ij}, and l_{ij} are the modal, upper bound, and lower bound values for x_{ij}, respectively [17].

Value of fuzzy synthetic extent

Let $C = \{C_1^1, C_2^1, \ldots, C_n^1\}$ be a criteria set, where n is the number of criteria and $M = \{M_1, M_2, \ldots, M_m\}$ is a DA set with m the number of DAs. Let $M_C{}^1{}_i$, $M_C{}^2{}_i$,...., $M_C{}^m{}_i$ be values of extent analysis of the ith criteria for m DAs. Here $i = 1, 2, \ldots, n$ and all the $M_C{}^j{}_i$ ($j = 1, 2, \ldots, m$) are triangular fuzzy numbers (TFNs). To make use of the algebraic operations on TFNs as described in the algebraic operations onTFNs, the value of fuzzy synthetic extent S_i with respect to the ith criteria is defined as:

$$S_i = \sum_{j=1}^{m} M_C{}^j{}_i \left[\sum_{i=1}^{n} \prod_{j=1}^{m} M_C{}^j{}_i \right]^{-1} \qquad (6)$$

Where it represents fuzzy multiplication and the superscript - 1 represents the fuzzy inverse. The concepts of synthetic extent can also be explained [18, 17].

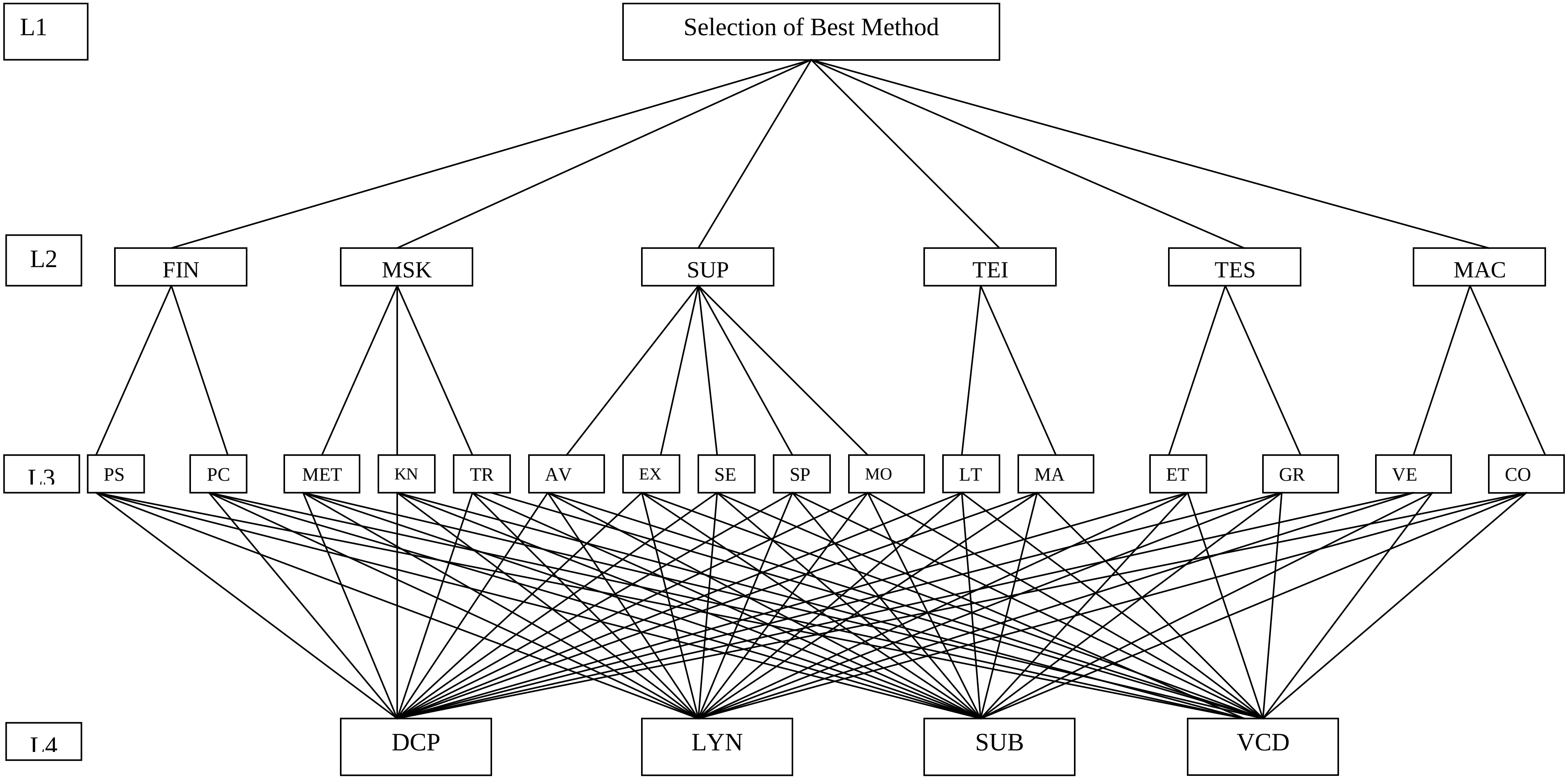


Figure 1. FAHP Hierarchy structure for Orodispersible Tablet Technique selection

Calculation of the sets of weight values of the FAHP

I . The Fuzzy Comparison Matrix Over Different Criteria

	FIN	MSK	SUP	TEI	TES	MAC	**N.V**
FIN	(1,1,1)	(1,3,5)	(2,4,6)	(4,6,8)	(5,7,9)	(7,9,11)	0.26
MSK	(1/5,1/3,1/1)	(1,1,1)	(1,3,5)	(3,5,7)	(5,7,9)	(6,8,10)	0.25
SUP	(1/6,1/4,1/2)	(1/5,1/3,1/1)	(1,1,1)	(1,3,5)	(3,5,7)	(5,7,9)	0.24
TEI	(1/8,1/6,1/4)	(1/7,1/5,1/3)	(1/5,1/3,1/1)	(1,1,1)	(2,4,6)	(4,6,8)	0.25
TES	(1/9,1/7,1/5)	(1/9,1/7,1/5)	(1/7,1/5,1/3)	(1/6,1/4,1/2)	(1,1,1)	(1,3,5)	0
MAC	(1/11,1/9,1/7)	(1/10,1/8,1/6)	(1/9,1/7,1/5)	(1/8,1/6,1/4)	(1/5,1/3,1/1)	(1,1,1)	0
							1.0

1.1 Formulation Information [FIN]

	PS	PC	**NV**
PS	(1,1,1)	(1/5,1/3,1/1)	0.3
PC	(1,3,5)	(1,1,1)	0.7
			1.0

1.2 Manufacture Skill [MSK]

	ME	KN	TR	**NV**
ME	(1,1,1)	(1,1,3)	(3,5,7)	0.5
KN	(1,1,3)	(1,1,1)	(3,5,7)	0.5
TR	(1/7,1/5,1/3)	(1/7,1/5,1/3)	(1,1,1)	0
				1.0

1.3 Supplier [SUP]

	AV	EX	SE	SP	MO	**NV**
AV	(1,1,1)	(1,1,3)	(1,3,5)	(1,3,5)	(1,3,5)	0.25
EX	(1,1,3)	(1,1,1)	(1,3,5)	(1,3,5)	(1,3,5)	0.25
SE	(1/5,1/3,1/1)	(1/5,1/3,1/1)	(1,1,1)	(1,1,3)	(1,1,3)	0.17
SP	(1/5,1/3,1/1)	(1/5,1/3,1/1)	(1,1,3)	(1,1,1)	(1,1,3)	0.16
MO	(1/5,1/3,1/1)	(1/5,1/3,1/1)	(1,1,3)	(1,1,3)	(1,1,1)	0.17
						1.0

1.4 Technical Information [TEI]

	MA	LT	**N.V**
MA	(1,1,1)	(1,3,5)	0.7
LT	1/5,1/3,1/1)	(1,1,1)	0.3
			1.0

1.5 Technical Status [TES]

	ET	GR	**N.V**
ET	(1,1,1)	(3,5,7)	1
GR	(1/7,1/5,1/3)	(1,1,1)	0
			1.0

1.6 Machine [MAC]

	CO	VE	**N.V**
CO	(1,1,1)	(1,3,5)	0.3
VE	(1/5,1/3,1/1)	(1,1,1)	0.7
			1.0

1.1.1 Production Scale [PS]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,3,5)	(7,9,11)	(4,6,8)	0.58
SUB	(1/5,1/3,1/1)	(1,1,1)	(3,5,7)	(1,3,5)	0.33
LYN	(1/11,1/9,1/7)	(1/7,1/5,1/3)	(1,1,1)	(1/5,1/3,1/1)	0
VCD	(1/8,1/6,1/4)	(1/5,1/3,1/1)	(1,3,5)	(1,1,1)	0.08
					1.0

1.1.2 Process Condition [PC]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,2,4)	(7,9,11)	(7,9,11)	0.71
SUB	(1/4,1/2,1/1)	(1,1,1)	(4,6,8)	(4,6,8)	0.29
LYN	(1/11,1/9,1/7)	(1/8,1/6,1/4)	(1,1,1)	(1,1,3)	0
VCD	(1/11,1/9,1/7)	(1/8,1/6,1/4)	(1,1,3)	(1,1,1)	0
					1.0

1.2.1 Method [ME]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,3,5)	(5,7,9,)	(3,5,7)	0.56
SUB	(1/5,1/3,1/1)	(1,1,1)	(3,5,7)	(1,3,5)	0.34
LYN	(1/9,1/7,1/5)	(1/7,1/5,1/3)	(1,1,1)	(1/5,1/3,1/1)	0
VCD	(1/7,1/5,1/3)	(1/5,1/3,1/1)	(1,3,5)	(1,1,1)	0.1
					1.0

1.2.2 Knowledge [KN]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,3,5)	(7,9,11)	(3,5,7)	0.56
SUB	(1/5,1/3,1/1)	(1,1,1)	(3,5,7)	(1,3,5)	0.34
LYN	(1/11,1/9,1/7)	(1/7,1/5,1/3)	(1,1,1)	(1/5,1/3,1/1)	0
VCD	(1/7,1/5,1/3)	(1/5,1/3,1/1)	(1,3,5)	(1,1,1)	0.1
					1.0

1.2.3 Training [TR]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,3,5)	(5,7,9,)	(5,7,9,)	0.56
SUB	(1/5,1/3,1/1)	(1,1,1)	(5,7,9,)	(5,7,9,)	0.34
LYN	(1/9,1/7,1/5)	(1/9,1/7,1/5)	(1,1,1)	(1,1,3)	0
VCD	(1/9,1/7,1/5)	(1/9,1/7,1/5)	(1,1,3)	(1,1,1)	0
					1.0

1.3.1 Availability [AV]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,2,4)	(4,6,8)	(5,7,9,)	0.55
SUB	(1/4,1/2,1/1)	(1,1,1)	(2,4,6)	(3,5,7)	0.41
LYN	(1/8,1/6,1/4)	(1/6,1/4,1/2)	(1,1,1)	(1,2,4)	0.04
VCD	(1/9,1/7,1/5)	(1/7,1/5,1/3,)	(1/4,1/2,1/1)	(1,1,1)	0
					1.0

1.3.2 Experience [EX]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,1,3)	(7,9,11)	(7,9,11)	0.5
SUB	(1,1,3)	(1,1,1)	(7,9,11)	(7,9,11)	0.5
LYN	(1/11,1/9,1/7)	(1/11,1/9,1/7)	(1,1,1)	1,1,3)	0
VCD	(1/11,1/9,1/7)	(1/11,1/9,1/7)	(1,1,3)	(1,1,1)	0
					1.0

1.3.3 Service [SE]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,1,3)	(7,9,11)	(7,9,11)	0.5
SUB	(1,1,3)	(1,1,1)	(7,9,11)	(7,9,11)	0.5
LYN	(1/11,1/9,1/7)	(1/11,1/9,1/7)	(1,1,1)	(1,1,3)	0
VCD	(1/11,1/9,1/7)	(1/11,1/9,1/7)	(1,1,3)	(1,1,1)	0
					1.0

1.3.4 Spares [SP]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,1,3)	(7,9,11)	(7,9,11)	0.5
SUB	(1,1,3)	(1,1,1)	(7,9,11)	(7,9,11)	0.5
LYN	(1/11,1/9,1/7)	(1/11,1/9,1/7)	(1,1,1)	(1,1,3)	0
VCD	(1/11,1/9,1/7)	(1/11,1/9,1/7)	(1,1,3)	(1,1,1)	0
					1.0

1.3.5 Monopoly [MO]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,1,3)	(5,7,9,)	(7,9,11)	0.5
SUB	(1,1,3)	(1,1,1)	(5,7,9,)	(7,9,11)	0.5
LYN	(1/9,1/7,1/5)	(1/9,1/7,1/5)	(1,1,1)	(1,1,3)	0
VCD	(1/11,1/9,1/7,)	(1/11,1/9,1/7,)	(1,1,3)	(1,1,1)	0
					1.0

1.4.1 Literature [LT]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,2,4)	(3,5,7)	(5,7,9,)	0.5
SUB	(1/4,1/2,1/1)	(1,1,1)	(1,3,5)	(3,5,7)	0.35
LYN	(1/7,1/5,1/3,)	(1/5,1/3,1/1)	(1,1,1)	(1,3,5)	0.15
VCD	(1/9,1/7,1/5)	(1/7,1/5,1/3,)	(1/5,1/3,1/1)	(1,1,1)	0
					1.0

1.4.2 Manual [MA]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,2,4)	(3,5,7)	(5,7,9,)	0.5
SUB	(1/4,1/2,1/1)	(1,1,1)	(1,3,5)	(3,5,7)	0.35
LYN	(1/7,1/5,1/3,)	(1/5,1/3,1/1)	(1,1,1)	(1,3,5)	0.15
VCD	(1/9,1/7,1/5)	(1/7,1/5,1/3,)	(1/5,1/3,1/1)	(1,1,1)	0

1.0

1.5.1 Established Technique [ET]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(3,5,7)	(6,8,10)	(7,9,11)	0.7
SUB	(1/7,1/5,1/3,)	(1,1,1)	(2,4,6)	(4,6,8)	0.3
LYN	(1/10,1/8,1/6)	(1/6,1/4,1/2)	(1,1,1)	(1/4,1/4,1/1)	0
VCD	(1/11,1/9,1/7)	(1/8,1/6,1/4)	(1,2,4)	(1,1,1)	0
					1.0

1.5.2 Growth [GR]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(3,5,7)	(6,8,10)	(7,9,11)	0.7
SUB	(1/7,1/5,1/3,)	(1,1,1)	(2,4,6)	(4,6,8)	0.3
LYN	(1/10,1/8,1/6)	(1/6,1/4,1/2)	(1,1,1)	(1/4,1/4,1/1)	0
VCD	(1/11,1/9,1/7)	(1/8,1/6,1/4)	(1,2,4)	(1,1,1)	0
					1.0

1.6.1 Complexity [CE]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,2,4)	(5,7,9,)	(7,9,11)	0.57
SUB	(1/4,1/2,1/1)	(1,1,1)	(3,5,7)	(5,7,9,)	0.43
LYN	(1/9,1/7,1/5)	(1/7,1/5,1/3)	(1,1,1)	(1,3,5)	0
VCD	(1/11,1/9,1/7,)	(1/9,1/7,1/5)	(1/5,1/3,1/1)	(1,1,1)	0
					1.0

1.6.2 Versatility [VE]

	DCP	SUB	LYN	VCD	**N.V**
DCP	(1,1,1)	(1,2,4)	(5,7,9,)	(7,9,11)	0.57
SUB	(1/4,1/2,1/1)	(1,1,1)	(3,5,7)	(5,7,9,)	0.43
LYN	(1/9,1/7,1/5)	(1/7,1/5,1/3)	(1,1,1)	(1,3,5)	0
VCD	(1/11,1/9,1/7,)	(1/9,1/7,1/5)	(1/5,1/3,1/1)	(1,1,1)	0
					1.0

Sample Calculation

Sum of rows and columns based on different criteria

	Row Sums			Column Sums		
MSK						
ME	5.0000	7.0000	11.0000	2.1428	2.2000	4.0000
KN	5.0000	7.0000	11.0000	2.1428	2.2000	4.0000
TR	1.2856	1.4000	1.6666	7.0000	11.0000	15.0000
Sum of columns				(11.2856,	15.4000,	23.6666)

.The associated S_i values can be found as follows

MSK

S_1= (5.0000, 7.0000, 11.0000). $(\frac{1}{23.6666}, \frac{1}{15.4000}, \frac{1}{11.2856})$ = (0.2112, 0.4545, 0.9746)

S_2= (5.0000, 7.0000, 11.0000). $(\frac{1}{23.6666}, \frac{1}{15.4000}, \frac{1}{11.2856})$ = (0.2112, 0.4545, 0.9746)

S_3= (1.2856, 1.4000, 1.6666). $(\frac{1}{23.6666}, \frac{1}{15.4000}, \frac{1}{11.2856})$ = (0.0543, 0.0909, 0.1476)

MSK

$(S_1 \geq S_2)=1$; $(S_1 \geq S_3)=1$;

$(S_2 \geq S_1)=1$; $(S_2 \geq S_3)=1$;

$(S_3 \geq S_1)=0$; $(S_3 \geq S_2)=0$;

	NORMALIZATIONVALUE (N.V)
ME= $V(S_1 \geq S_2, S_3)=\min(1,1)=1$	0.5
KN= $V(S_2 \geq S_1, S_3)=\min(1,1)=1$	0.5
TR = $V(S_3 \geq S_1, S_2)=\min(0,0)=0$	0

To obtain the estimates for the sets of weight values under each criterion, it is necessary to consider a principle of comparison for fuzzy numbers [20]. For an example, for two fuzzy numbers M_1 and M_2, the degree of possibility of $M_1 \geq M_2$ is defined as:

$$V(M_1 \geq M_2) = \sup_{x > y} [\min (\mu_{M1}(x), \mu_{M2}(y))],$$

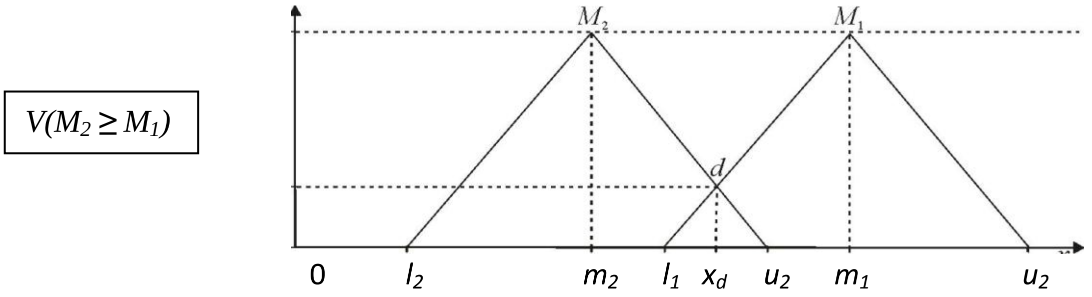
Where sup represents supremum (i.e., the least upper bound of a set) and when a pair (x, y) exists such that $x \geq y$ and $\mu_{M1}(x) = \mu_{M2}(y) = 1$, it follows that $V(M_1 \geq M_2) = 1$ and $V(M_2 \geq M_1) = 0$. Since M_1 and M_2 are convex fuzzy numbers defined by the TFNs (l_1, m_1, u_1) and (l_2, m_2, u_2) respectively, it follows that

$$V(M_1 \geq M_2) = 1 \text{ iff } m_1 \geq m_2;$$
$$V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_{M1}(x_d), \qquad (7)$$

where iff represents "if and only if" and d is the ordinate of the highest intersection point between the μ_{M1} and μ_{M2} TFNs is shown in Fig-1 and x_d is the point on the domain of μ_{M1} and μ_{M2} where the ordinate d is found. The term hgt is the height of fuzzy numbers on the intersection of M_1 and M_2. For $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, the possible ordinate of their intersection is given the equation (7). The degree of possibility for a convex fuzzy number can be obtained from the use of equation (8).

$$l_1 - u_2$$

$$V(M_2 \geq M_1) = \mathrm{hgt}\,(M_1 \cap M_2) = \frac{}{(m_2-u_2)-(m_1-l_1)} = d \qquad (8)$$



The degree of possibility for a convex fuzzy number M to be greater than the number of k convex fuzzy numbers M_i ($i = 1, 2,\ldots, k$) can be given by the use of the operations max and min [21] and can be defined by:

$V(M \geq M_1, M_2, \ldots, M_k) =$
$V[(M \geq M_1)$ and $(M \geq M_2)$ and … and $(M \geq M_k)]$
$= \min V(M \geq M_i)$, $i = 1, 2, \ldots, k$.

Assume that $d'(A_i) = \min V(S_i \geq S_k)$, where $k = 1, 2, \ldots, n$, $k \neq i$, and n is the number of criteria as described previously. Then a weight vector is given by:

$$W' = (d'(A1), d'(A_2), \ldots, d'(A_m)), \qquad (9)$$

where A_i $(i = 1, 2, \ldots, m)$ are the m DAs. Hence each $d(A_i)$ value represents the relative preference of each DA. To allow the values in the vector to be analogous to weights defined from the AHP type methods, the vector W is normalised and denoted

$$W = (d(A1), d(A_2), \ldots, d(A_m)), \qquad (10)$$

One point of concern, highlighted in this paper, is when two elements (fuzzy numbers, say $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ in a fuzzy comparison matrix satisfy $l_2 - u_2 > 0$ then $V(M_2 \geq M1) = \mathrm{hgt}(M_1 \cap M_2) = \mu_{M2}(x_d)$, with $\mu_{M2}(x_d)$ given by [22]

$$\mu_{M2}(x_d) = \begin{cases} \dfrac{l_1-u_2}{(m_2-u_2)-(m_1-l_1)} & l_1 \leq u_2 \\ 0 & \end{cases} \qquad (11)$$

RESULTS & DISCUSSION

The concept of present study was applied to the all data for the selection of best method to develop better oral disintegrating tablets. The redefinition of the proportional distance between lower bound and upper bound values associated with fuzzy numbers in the FAHP is applied in a practical environment to reach a decision into formulate oral disintegrating tablets.

The process of weight evaluation

The evaluation of the weight can be expressed by applying the modified FAHP extent analysis method to all data to select of best method of formulation as described above. In this study the degree of fuzziness is set at 2.

Weights evaluation for criteria

Table: 1 The sets of weight values for all fuzzy comparison matrix and final results obtained when δ= 2 based on the DM's opinions

	Criterias	Weight values for DAS					Weight values for criteria
		DAs	**DCP**	**SUB**	**LYN**	**VCD**	
1	**FIN**	**PS**	0.17	0.09	0	0.02	0.3
		PC	0.49	0.20	0	0	0.7
2	**MSK**	**ME**	0.28	0.17	0	0.05	0.5
		KN	0.28	0.17	0	0.05	0.5
		TR	0	0	0	0	0
3	**SUP**	**AV**	0.13	0.10	0.01	0	0.25
		EX	0.12	0.12	0	0	0.25
		SE	0.08	0.08	0	0	0.17
		SP	0.08	0.08	0	0	0.16
		MO	0.08	0.08	0	0	0.17
4	**TEI**	**MA**	0.35	0.24	0.10	0	0.7
		LT	0.15	0.10	0.04	0	0.3
5	**TES**	**ET**	0.7	0.3	0	0	1
		GR	0	0	0	0	0
6	**MAC**	**VE**	0.39	0.29	0	0	0.7
		CO	0.17	0.12	0	0	0.3
		Final results	**3.47**	**2.14**	**0.15**	**0.12**	
		Ranking orders	**(DCP > SUB > LYN > VCD)**				

We used fuzzy numbers 1� to9� to capture the fuzziness and uncertainty in the evaluation process by using this approach. The first stage of the weight evaluation process is the aggregation of l_{ij}, m_{ij}, and u_{ij} values present in the pair wise comparison matrix for the judgments between criteria. Following the fuzzy synthetic extent concept shown in equation

(6), the evaluation with respect to the six criteria in terms of the 1-9 scale from Saaty (1980) based on δ = 2 .We proposed a structural model for selection of best method for ODTs evaluation and evaluated six criteria from four method. The transformation procedures for comparisons between criteria based on other alternative scales can be found, and the final results based onδ= 2 are shown in Table: 2. DCP has the largest weight while δ= 2. It reveals that DM prefers the DCP with 3.47as normalization value, over the others as SUB, LYN, and VCD with 2.14, 0.15, and 0.12 as normalization value respectively. The method M_1 Direct compression suits best for formulation information, manufacture skill, supplier, technical information, technical status and machine than all the methods stated in this article. The normalization values are calculated from the triangular fuzzy values for all sub attributes such as PS, PC, AV, EX, SE, SP, MO, MA, LT, ET, GR, VE and CO for the all formulation techniques and tabulated in table: 2.

CONCLUSION

The selection of best method for the evaluation of ODTs is complicated because it involves a considerable amount of fuzziness, vagueness, ambiguity or uncertainty in the modeling and decision making process. Consequently we employed a fuzzy AHP approach to deal with this evolution problem. This technique is more systematic than the others technique and it is more capable of capturing of a human's appraisal of ambiguity when the complex multi-attribute decision-making problem are considered.

It is found that the DM of the selection of best method for ODTs formulation successfully made the necessary judgements.This includes an all allowances to not make specific pairwise comparisons between all pairs of decision alternatives, the incompleteness of another aspect of the possible inherent uncertainty in the decision process. The redefinition of degree of fuzziness associated with the preference judgments made allows the change of imprecision to be succinctly reported.

Among the criteria in the best method selection problem was accommodation of high dose at lower processing cost and disintegrate with in few seconds in the oral cavity; from its definition this has an associated value with each alternatives and hence it is a tangible criterion. This study reveals that DCP method is most appropriate technique for the formulation of ODTs than the other technique.

REFERENCES

[1] Valliappan K, Kannan K, Manavalan R, Muralidharan. Indian Drugs 2002; 39(5): 277-289.

[2] Kaufman A, Gupta KK.Fuzzy Mathematical Models in Engineering and Management Science. Elsevier Science Publishers B.V., North Holland, Amsterdam, 1988.

[3] Cheng CH, Mon DL. Fuzzy Sets and Systems 1994; 63:1-10.

[4] Saaty TL.Fundamentals of Decision Making and Priority Theory. 2000, 2nded. Pittsburgh, PA: RWS Publication.

[5] Zahedi F. Interfaces 1986; 16(4): 96-108.

[6] Huang H, Miller GY.Evaluation of Swine Odor Management Strategies in a Fuzzy Multi-Criteria Decision Environment. American Agricultural Economic Association Annual Meeting, Montreal, Canada, 2003.

[7] Bozdağ CE, C Kahraman, D Ruan. Fuzzy Group Decision Making For Selection among Computer Integrated Manufacturing Systems, Computers in Industry, 2003; 51: 13-29.

[8] Davis J P, J W Hall. Decision Support Systems 2003;35:415-433.

[9] Chiu CY, Park CS. The Engineering Economist 1994; 39(2): 113–137.

[10] Orlando Duran, José Aguilo. Expert System with Application 2008; 34: 1787-1794.

[11] Hepu Deng. International Journal of Approximate Reasoning 1999; 21: 215-231.

[12] Chin-Tasi Lin, Cheng-Ru Wu, Huang-Chu Chen. Information and Management Sciences 2008; 19(1):175-200.

[13] Giachetti R, Young R E. Fuzzy Sets and Systems 1997; 91: 185-202.

[14] Liang GS, Wang MJJ. Robotics & Computer-Integrated Manufacturing, 1993; 10: 267-274.

[15] Kuo R J, Chi S C, Kao S S. A Decision Support System for Selecting Convenience Store Location through Integration of Fuzzy AHP and Artificial Neural Network, Computers in Industry, 2002; 47: 199-214.

[16] Chiou HK, Tzeng GH. International of Fuzzy System 2001; 3: 466-475.

[17] Yu-Cheng Tang, MalcolmJ.Beynon. Journal of Economics and Management, 2005; (1)2:207-230.

[18] Cheng CH. Fuzzy Sets and Systems 1999;107: 25-35.

[19] Kwiesielewicz M. Fuzzy Sets and Systems 1998; 95:161-172.

[20] Chang DY. European Journal of Operational Research 1996; 95: 649-655.

[21] Dubois D, Prade H. Fuzzy Sets and Systems: Theory and Applications, New York: Academic Press, 1980.

[22] Zhu KJ, Jing Y, Chang DY. European Journal of Operational Research 1999; 116: 450-456.

[23] Yu C S. Computers & Operations Research 2002; 29: 1969-2001.

[24] Vijay Sharma, AnilK Philip, Kamal Pathak. American Association of Pharmaceutical Scientists 2008;9(1):87-94.

[25] Rapidly dissolving tablet. U.S.Patent No: 5807576

[26] Process for making a particulate support matrix for making a rapidly dissolving tablet., U.S.Patent No: 5587180