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Analytical hierarchy process: A multi-criteria decision making approach for nanoparticles preparation method

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ABSTRACT

In our present work an analytical tool has been used to prioritize the suitable method used for the fabrication of nanoparticles containing few bioflavonoids. Nevertheless, quite a lot of preparation methods are available for the manufacturing of nanoparticles and it is very essential to select one such method, possessing the potential for successful fabrication of nanoparticles containing one or more bioflavonoids. Otherwise the usage of such analytical tool, in appropriate selection of methods is very vital to curb, the unnecessary time consumption of trying out at all methods available, which in turn escalates time and material resources. That has been the reason, here for employing Analytical Hierarchy Process for the selection of suitable fabrication methods for the nanoparticles. The Analytical Hierarchy Process was designed with the primary goal in the first stage (Goal-1) and second stage (Criterion-10) with various factors which influences the preparation method and thirdly with all sort of preparation methods (Sub criterion-10). A pair-wise comparison method has been performed between the ten criterions with each of ten sub-criterions the points were allotted using Saaty's scale ranks ranging 1 to 9. The experimentation results revealed that nanoprecipitation method, which has gained a maximum priority points as compared with other methods. Hence, the nanoprecipitation method has been selected as the suitable nanoparticles preparation method for the fabrication of nanoparticles containing one or more bioflavonoids. At this juncture, it has also been observed as the Analytical Hierarchy Process method selection tool's utilization for the method selection of nanoparticles.

Keywords: Selection of methods, Nanoparticles, Multi Criteria decision making tool, Priority weights.

INTRODUCTION

Basically various methods are available for the manufacturing of any dosages, it has been very essential to select the method, which is quite suitable for the manufacturing process. Erstwhile, has been performed by various Analytical deciding tool, deployment of such tools are inevitably important to reduce the time, manpower and material resources. In these type of analytical technique all the necessary parameters influencing the process are compiled with

the available method options. In later stage all the parameters are compared by lending the priority weights to the methods viz-a-viz influencing parameters[1-7]. After obtaining the priority points, they are compared with one another to get the method that has got a maximum score or rank. Hence, the method resulting in analytical tool selected has been the best method for the preparation methods

An analytical hierarchy model was developed by the goal in the first level, ten criterion in the secondary variables and ten methods in the third position[8].

MATERIALS AND METHODS

Analytical tool for method selection can be done at various levels

Primarily- Goal setting (Method selection)

Secondarily- Selection of criteria (Parameters influencing)

Thirdly- Selection of Sub criteria (Methods available/option)

The Criteria and sub criteria has to been compared pair-wise each other and priority weight were allotted for each comparison using scale of Saaty's designed in 1970 by Dr. Thomas Saaty L[9-11].

Assessing the relative importance of criteria

All 10 options were evaluated by scale of Saaty's, which results in the pattern of the pair-wise comparison matrix. Pair-wise comparison begins with comparing the relative importance of two criteria. There are n x (n-1) judgments necessary to develop the set of pair-wise comparison matrix. The decision makers have to compare judge each criteria using scale of Saaty's. The judgments are decided on the basis of the decision makers' or users' experience and skill. For instance, when making pair evaluation, if criterion B1 is strongly more important or essential than B2, then B1 equal to 5 and B2 equal to 1/5[12].

Comparing option for each criterion

All ten methods were compared with each other for each criterion using scale of Saaty's, which results in the formation of the pair-manner comparative. Pair-wise comparison begins with comparing the relative importance of two methods. There are n x (n-1) judgments essential to develop the set of pair-wise comparison matrix. The decision makers have to compare/judge each method using scale of Saaty's. The judgments are determined on the basis of the conclusion makers' or users' experience and knowledge. For paradigm, when making pair-manner determination, if method P1 is strongly more significant or essential than P2, then P1 = 5 and P2 = 1/5.

Determination of overall ranking

From the paired comparison, priority weights were obtained and weights were given based on by and large weights. Priority weights and ranking of criteria preferences were summarized in Table 13.15 and Figure 13.19. Out of 10 criteria, process simplicity (B2) received the maximum largely rank weights (0.1989) by necessary size (B2: 0.4022) and easy availability of instruments (B5: 0.0938). Analytical hierarchy process decision-making tool has recognized reproducible results as per preference for the preparation of dual packed bioflavonoid nanoparticles.

Structuring multiple choice criteria into a hierarchy

A hierarchy model was developed with three levels.

Goal: Level-1

Selection of method for Nanoparticle preparation

Criteria: Level-2

B1, B2, B3, B4, B5, B6, B7, B8, B9, B10

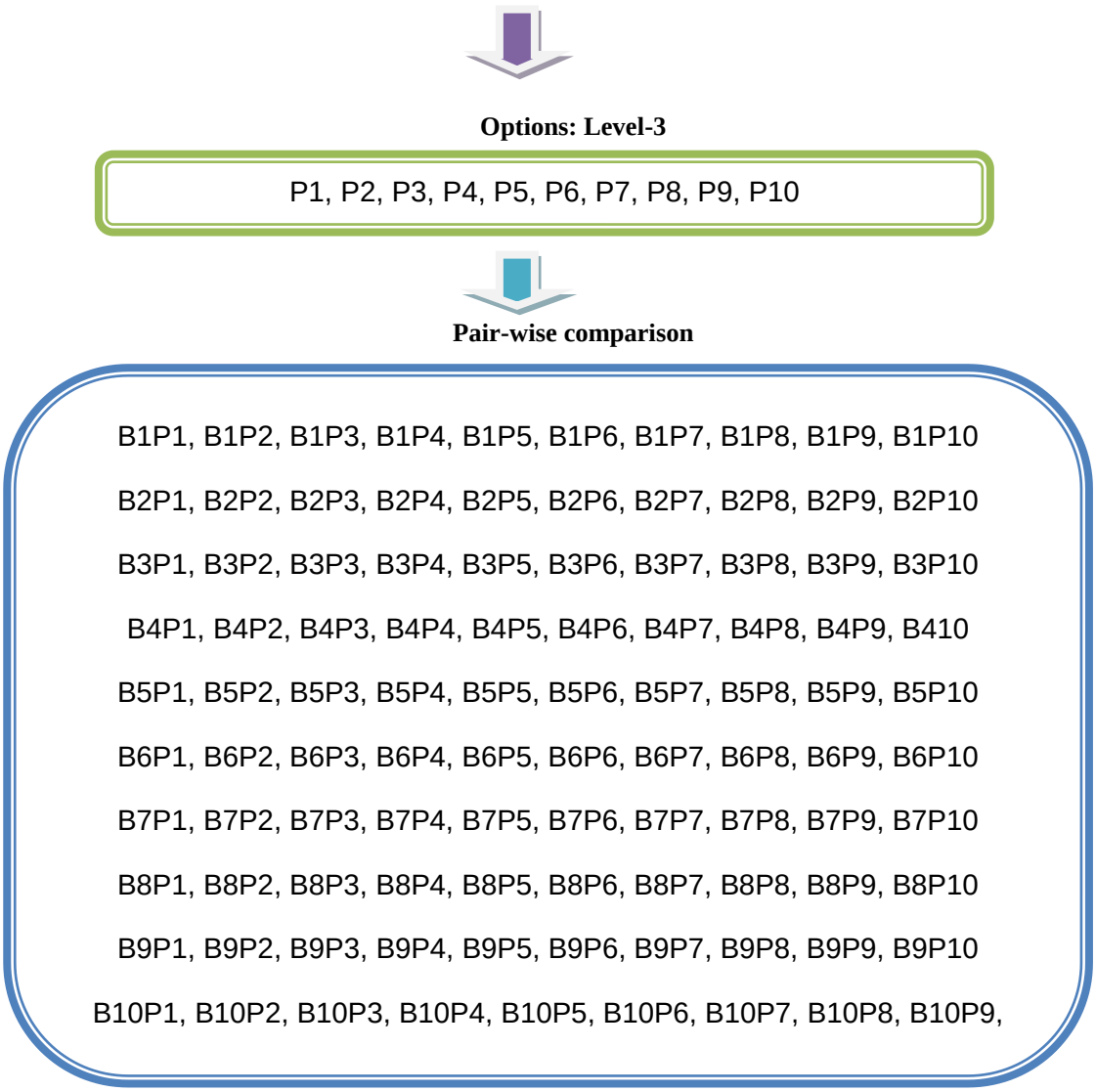

Figure 1: Selection of suitable techniques for the preparation of flavono loaded polymeric nanoparticles using AHP

Arranging the goal in the first level, 10 main criteria in the second levels, and polymeric nanoparticles preparation technique in the third level.

Table 1: Evaluation criteria

S.No	Evaluation criteria	Abbreviation /code
1	Availability of instruments at ease	B1
2	Process simplicity	B2
3	Parameter accessories	B3
4	Knowledge of operating personnel	B4
5	Reproducibility	B5
6	Excipients availability	B6
7	Size of desired dimension for particles	B7
8	Pilot scale up	B8

9	Percentage yield	B9
10	More economical	B10

Table 2: Polymeric nanoparticles preparation methods

S.No	Options	Abbreviation /code
1	Desolvation method	P1
2	Nanoprecipitation method	P2
3	Super critical fluid	P3
4	Nanospray drying	P4
5	Dialysis method	P5
6	Ionic gelation method	P6
7	Salting out method	P7
8	Polymerization method	P8
9	Polycondensation method	P9
10	Direct solvent evaporation method	P10

Finding the relative implication of criterion

All criteria were compared with each other to find out the relative significance of criteria. However, during comparison the weights were assigned as per the Saaty's scale (Table 6.4), which in turn formation of the pair-manner comparison.

Table 3: Saaty's scale[12]

Importance	Weights	
	I^{th} Vs J^{th}	J^{th} Vs I^{th}
Equally important	1	1
Equally to moderately more important	2	1/2
Moderately more important	3	1/3
Moderately to strongly more important	4	1/4
Strongly more important	5	1/5
Strongly to very strongly more important	6	1/6
Very strongly more important	7	1/7
Very strongly to extremely more important	8	1/8
Extremely more important	9	1/9

Comparing alternatives for each criterion

All the methods for the preparation of flavono polymeric nanoparticles were compared with each other for each criterion. In due course of comparing, weights were assigned as per guidance of Saaty's scale, which results in the formation of the pair-manner evaluation matrix. Consistency ratio was determined for each pair comparison matrix as mentioned above[13-15]. Consistency ratio (CR) was carried out for the pair manner comparison as follows [CR=CI/RI], where CI is consistency index and calculated as CI = $(\lambda_{max}-n)/(n-1)$

RESULT AND DISCUSSION

Overall ranking prioritization

An overall ranking for the selected criteria was performed as follows,

- Priority weights are considered and compared in a pair manner
- Average Normalized Column- method has been used for prioritization
- In this evaluation the components of each column has been divided by sum of the column.
- The elements in the each row were summed and this is divided by the components of each row.
- The above process has produced a result of selected method effectively as shown in the table 4
- In this priority weights method the following formula is used,

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\frac{aij}{\sum_i^n a_{ij}}, i, j = 1, 2, \cdots n$$

Table 4: Overall ranking based on priorities

S. No	Methods	Code	Priority	Ranking
1	Desolvation method	DSM	0.0570	10
2	Nanoprecipitation method	NPM	0.3698	1
3	Super critical fluid method	SFM	0.0651	6
4	Nano spray drying	NSM	0.0852	3
5	Dialysis method	DLM	0.0602	8
6	Ionic gelation	IGM	0.0928	2
7	Salting out method	SOM	0.0741	4
8	Polymerization method	PLM	0.0590	9
9	Polycondensation method	PCM	0.0645	7
10	Direct solvent evaporation method	DEM	0.0723	5

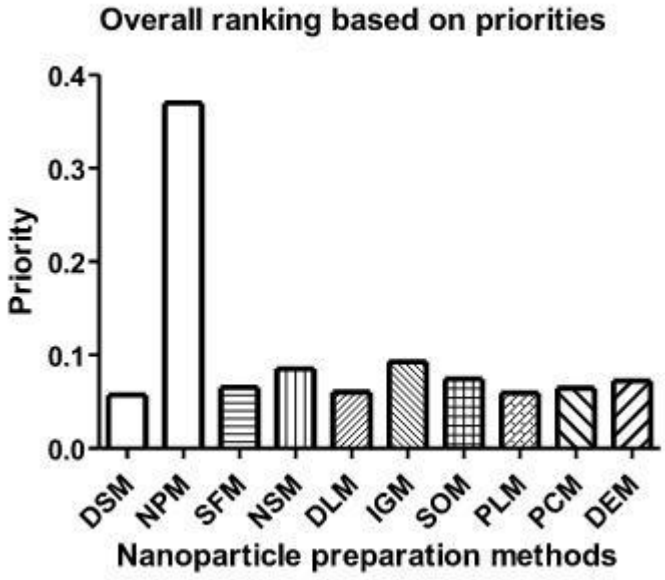

Figure 2: Priority weights and ranking of methods with criteria

The goal of the analytical hierarchy process has been set up as selection of nanoparticles preparation method. Since there are various dependent factors which affect the The priority weights allotted for the selected variables pair-wise comparison

Priority weights and ranking of method were summarized, out of 10 methods, nanoprecipitation (P5) received the maximum overall priority weights (0.3698) followed by ionic gelation (P6: 0.0928) and nanospray method (P4: 0.0852). Analytical hierarchy process decision-making tool has recognized nanoprecipitation as an optimal method for the preparation of dual packed flavono polymeric nanoparticles.

CONCLUSION

In this study design, an approach has been made for the suitable preparation method selection for the nanoparticles. It was found effective and obvious that, the exploitation of Analytical Hierarchy Process for the method selection of appropriate nanoparticle preparation was ideal, with the numerous contemporary methods available. In this experimentation the nanoprecipitation method was found suitable for the nanoparticle fabrication with bioflavonoids and Analytical Hierarchy Process was an effective stratagem for method selection.

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