

# Taste Masking of Ayurvedic Nutraceutical Formulation by Pan Coating Process

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## ABSTRACT

**Background:** Ayurvedic medicines and nutraceuticals are gaining popularity among physicians and patients for better therapeutic value. Lack of quality standards and problems, in preparing or testing them, are the main hurdles experienced by both the practitioners and the patients. **Objective:** The objective of the study was to improve the palatability of the Ayurvedic Nutraceutical Preparation (ADS) by masking its bitter taste and to standardize the taste masking procedure. In the present study Eudragit E 100 was used as an acid soluble coating material. **Materials and Methods:** ADS powder was converted into granules with PVP K30 as a granulating agent and the ADS granules were coated with Eudragit E 100 coating solution by pan coating process. Various IPQC tests namely flow properties, moisture content were performed on the granules before and after coating for determination of endpoint of granulation and coating respectively. The ADS powder and granules were evaluated for bitter taste. **Results:** ADS granules were advantageous over ADS powder since the flow properties of ADS granules were better than the flow properties of ADS powder, a prerequisite of pan coating process. Eudragit E 100 inhibited the contact in between the plant extracts and the taste buds due to insolubility of Eudragit E 100 in saliva. Sensory evaluation of taste indicated that the taste of coated granules was significantly masked. **Conclusion:** The bitter taste of ADS was improved successfully with Eudragit E 100 as a coating agent and the pan coating process. An attempt was made to standardize the pan coating process.

**Key words:** Ayurveda, Coating, Eudragit E 100, Nutraceutical, Taste Masking.

## INTRODUCTION

Ayurvedic literature suggests use of herbal, mineral and herbo-mineral preparations in various dosage forms for centuries. Traditional knowledge inspired Dietary Supplements are nowadays being promoted for their perceived health benefits. The major challenge for the ayurvedic nutraceutical industry in using the medicinal plant extracts is the palatability of extracts.<sup>1</sup>

Plants protect themselves against herbivorous animals by producing secondary metabolites namely, phenols,

flavonoids, isoflavones, terpenes, and glucosinolates. The secondary metabolites, having bactericidal or biological activity, are used therapeutically. These substances are almost always bitter, acrid, or astringent and may provide a defense against predators by making the plant unpalatable.<sup>2</sup>

Taste masking is defined as a perceived reduction of an undesirable taste that would otherwise exist.<sup>3</sup> Molecule interacts with taste receptors, in taste buds, on the tongue to give bitter, sweet or other taste sensation, when it dissolves in saliva. The taste buds contain very sensitive nerve endings, which produce and transmit electrical impulses via the seventh, ninth and tenth cranial nerves to those areas of the brain, which are devoted to the perception of taste.<sup>4</sup>

The taste masking includes physical and chemical means that prevent the interaction of the drug substance with the

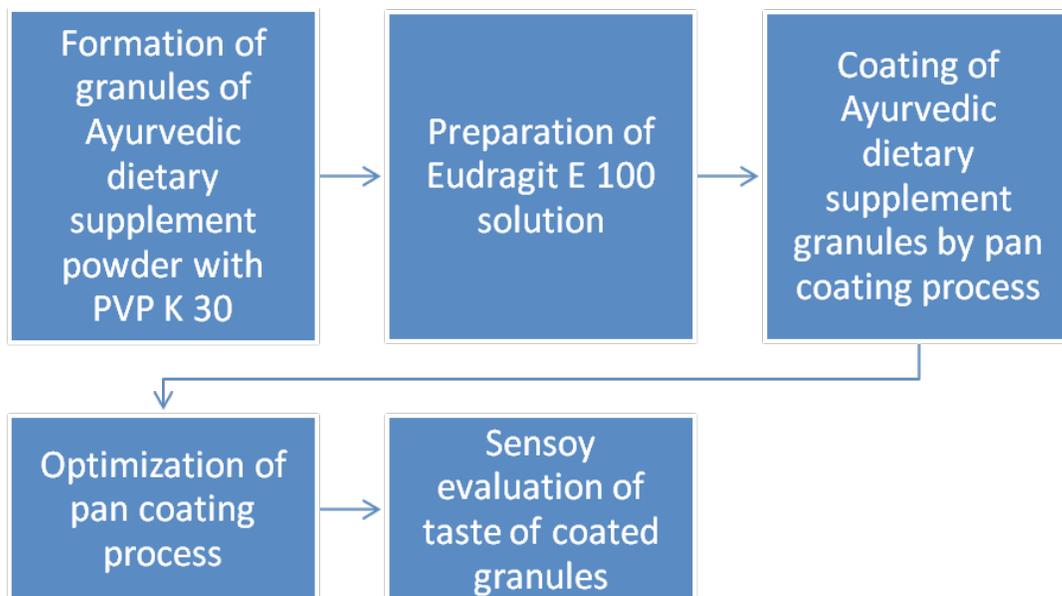
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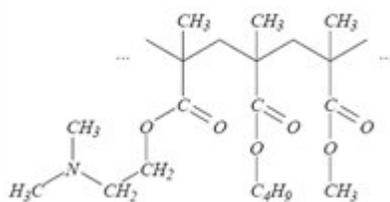


### Graphical Abstract

taste buds. The commonly employed methods for achieving taste masking are use of flavor enhancers, coating of drug particles with inert agents, taste masking by formation of inclusion complexes and molecular complexes, microencapsulation of drug, formation of solid dispersions, multiple emulsions of drug, use of ion exchange resins and prodrugs, drug entrapment in liposomes, taste masking by viscosity modifications.<sup>5</sup>

An ideal taste masking process and formulation should involve least number of equipments and processing steps. It should require minimum number of excipients for an optimum formulation. The taste masking process should not affect the bioavailability of the drug adversely. The excipients, used for taste masking, should be economical, easily available and should have high margin of safety.<sup>4</sup>

Eudragit E 100 (Figure 1) is a cationic copolymer of (2-dimethylaminoethyl) methacrylate, butyl methacrylate, and methyl methacrylate in the ratio of 2:1:1. It is used



**Figure 1: Eudragit E 100**

frequently for taste masking since it is soluble up to pH 5; however it is swellable and permeable above pH 5.8. Eudragit E 100 is insoluble in saliva; however it becomes water soluble at gastric pH via salt formation with acids thus providing gastro soluble coatings. Eudragit E 100 coatings are moisture protective due to very low water vapor permeability. Moreover, good storage stability, protection of sensitive actives and improved passage of the dosage form across gastrointestinal tract (GIT) are further advantages of Eudragit E 100 coatings. No plasticizer is needed for Eudragit E 100 as it is soft enough to build flexible coatings.<sup>6,7</sup>

An ayurvedic dietary supplement (ADS), consisting of medicinal plant extracts, was reported as bitter in taste by diabetic patients. The objective of this investigation was to improve the palatability of the preparation for better compliance from the end user. The study was focused at masking the bitter taste of ADS by preventing the contact of ADS with taste buds, without affecting its absorption from the GIT. Eudragit E 100 was applied as a coating agent by pan coating process. Another important objective was standardization of the pan coating process.

### MATERIALS AND METHODS

Ayurvedic dietary supplement in powder form was procured as a gift sample from Vaidya Ajit Kolatkar Pune, India. Eudragit E 100 and polyvinyl pyrrolidone K 30 (PVP K 30) were purchased from Anil Suppliers, Pune, India. All other ingredients used were of analytical grade.

**Table 1: Coating parameters for coating of ADS granules**

Coating Parameter	Value
Pan speed	16-20
Pump rpm	1
Inlet temperature	50-55°C
Atomization air pressure	Low
Spray rate	3-5 ml/min

### *Characterization of ADS powder*

The ayurvedic dietary supplement (ADS) powder was evaluated for the physical properties namely, color, appearance, taste, particle size, bulk density, tapped density (Electrolab Tap density tester USP ETD-1020), compressibility index, Hausner's ratio and the angle of repose.<sup>8</sup> Bulk density was determined by the IP method I; tapped density was determined by tapping the sample 500 times. The moisture content of ADS powder was determined.<sup>9</sup>

### *Preparation of ADS Granules*

PVP K30 was used as a granulating agent for converting ADS powder to ADS granules. ADS powder (50 gm) was mixed with 5% w/v aqueous solution of PVP K30 (30 ml) in a glass pestle mortar for 5 minute manually to form a cohesive mass. The cohesive mass was sieved through sieve 10 to obtain the granules. The granules were dried at 60°C for 2 hours.

### *In Process Quality Control (IPQC) Tests for ADS Granules*

The ADS granules were evaluated for the physical properties namely, bulk density, tapped density, compressibility index, Hausner's ratio and the angle of repose.<sup>8</sup> The moisture content of ADS granules was determined.

### *Preparation of Coating Solution*

The coating solution of Eudragit E 100 (70 ml) was prepared by dissolving Eudragit E 100 (0.025% w/v) in ethanol (99% v/v) with gentle stirring, on a mechanical stirrer at 50 rpm for 10 minute, till a clear solution was observed. The coating solution was passed through 100 mesh screen and used for coating.<sup>10</sup> The relative density of coating solution was determined.<sup>9</sup>

### *Coating of ADS granules*

The ADS granules were coated by pan coating process with the coating parameters.<sup>11</sup> (Table 1) A side-vented

Accela Cotta R & D Tablet coating machine, (Ideal Cures, Mumbai) having a pan diameter of 4" and fitted with a spray gun, was used to coat the ADS granules. ADS granules (50 g) were introduced into the coating pan of the Accela tablet coater rotating at a rate of 10-16 revolutions per min (rpm). The exhaust for dry air was turned on and the temperature of the set up was allowed to reach the maximum of 55°C. Before application of coating solution, the granules were pre-warmed at 55°C for 10 minutes at slow rpm or by inching. The nozzle of the spray gun was directed at the centre of the rotating pan, the gun height was adjusted at 25 cm and Eudragit E 100 coating solution was pumped continuously on to the rotating granule bed at a spray rate of 3-5 ml/min. The coating was dried by allowing hot air intermittently on the rotating granule bed (drying period 5 min). The ADS granules were stirred during drying to prevent aggregation. After coating, the granules were post dried for 10 to 15 minutes at slow rpm or by inching. The coating solution was applied to the granule bed till the weight gain was 3% w/w. For 50 g of ADS granules, 58 ml of coating solution was added. The duration of coating was 3 hours.

### *In Process Quality Control (IPQC) Tests for Coated ADS Granules*

The ADS coated granules were evaluated for angle of repose, bulk density, tapped density, compressibility index, Hausner's ratio to determine the flow properties.<sup>8</sup> The moisture content and the residual solvent (alcohol) in the coated granules was determined.<sup>9</sup>

### *Evaluation for Taste Masking*

Sensory evaluation of bitter taste of ADS powder, uncoated and coated ADS granules was determined by a single blind cross-over study based on taste recognition by six volunteers from whom informed consent was obtained.<sup>12</sup> The volunteers were instructed to keep the ADS powder, uncoated and coated ADS granules in the centre of the tongue and not to swallow the powder or the granules. The powder/ granules were retained in the mouth for 30 seconds, and then the mouth was thoroughly rinsed with distilled water. The response of the volunteers was recorded on the bitterness scale (0=good, 1=tasteless, 2=slightly bitter, 3=bitter, 4=very bitter).

## **RESULTS AND DISCUSSION**

### *Characterization of ADS powder*

The ADS powder was yellowish and dry. The particle size was 250  $\mu$  since the powder was passed through sieve 60.

**Table 2: Flow properties of ADS granules**

Property	ADS powder	ADS Uncoated granules	ADS Coated granules
Angle of repose	49.28°	43.28°	36.51°
Bulk density	0.204 g/ml	0.377 g/ml	0.491 g/ml
Tapped density	0.328 g/ml	0.512 g/ml	0.585 g/ml
Carr's index	37.8%	26.25%	16.06%
Hausner's ratio	1.60	1.35	1.19
Moisture content	13.62%	34.41%	9.38%

According to angle of repose-compressibility-flowability correlation data, if angle of repose is 46-55°, it means poor flow property. If compressibility index and Hausner's ratio is 31-37 and 1.46-1.59 respectively, it means very poor flowability. The ADS powder revealed very poor flow properties.<sup>8</sup> (Table 2)

#### *Preparation of ADS Granules*

Taste masking of ADS powder was performed in 2 stages, namely preparation of granules of ADS powder and coating of ADS granules with a polymer solution.<sup>13</sup> Powders, especially herbal in origin, are bitter in taste. Since powders have smaller particle size, coating of individual particle and masking of bitter taste is expensive and time consuming. Granules are advantageous over powders since they have better flow properties, compressibility, physical and chemical stability, particle size uniformity as compared to powders. Granules have a smaller surface area than a comparable volume of powder leading to better wettability. Granules require less coating solution and can be coated uniformly.<sup>14</sup> ADS powder was converted into granules.

PVP is a widely used excipient for the preparation of solid dosage forms. It is readily soluble in water and other polar solvents. PVP K 30 is a very good binder for effervescent tablets, as it dissolves rapidly in water to form a clear solution. Wet granulation with PVP K-30 generally gives hard and compact granules with good flow properties. Due to high binding strength, PVP K 30 is suitable for wet granulation and direct compression. PVP K 30 was used as a granulating agent for preparation of ADS granules.<sup>15,16</sup>

#### *In Process Quality Control (IPQC) Test for ADS Granules*

IPQC tests are checks performed during production in order to monitor and, if necessary, to adjust the process, to ensure that the product conforms to its specifications. In-process controls are usually performed within the

production area and are accomplished by identifying the critical steps in manufacturing and controlling them within defined limits. In-process inspection and testing is performed by monitoring the process or by actual sample analysis at defined locations and times. In general, the in process control procedures are usually rapid and simple tests or inspections that are performed, when the manufacturing of a product batch is in progress. IPQC tests ensure the uniformity, purity and quality of finished dosage forms within a batch and between batches.<sup>17</sup>

The flow properties and moisture content of ADS granules were studied for determination of endpoint of granulation, in turn for standardization of granulation. (Table 2) Adequate flow properties ensure uniform coating of the granules by the coating agent in subsequent stage. According to angle of repose-compressibility-flowability correlation data, if angle of repose is 41-45°, it means passable flow property. If compressibility index and Hausner's ratio is 26-31 and 1.35-1.45 respectively, it means poor flowability.<sup>8</sup> ADS granules exhibited poor flow properties. If the moisture content of granules is too high, the granules are wet resulting in improper coating. If the moisture content is too low, the granules are friable and the particle size will reduce in the coating pan. In the present study, ADS granules exhibiting poor flow properties and moisture content of 34.41% were used for further study.

#### *Coating of ADS granules*

Eudragit E 100 (Aminoalkyl methacrylate copolymer) dissolves under acidic conditions/low pH but not at neutral pH. It becomes water-soluble via salt formation with acids, thus providing gastrosoluble film coatings. These films are soluble below pH 5 and swellable and permeable above pH 5. The pH of saliva ranges from 6.2 to 7.4. Ishikawa *et al* concluded that the taste masked granules can be prepared with Eudragit E 100.<sup>10</sup> In the present study Eudragit E 100 was used as an acid soluble coating material. The coating of Eudragit E 100 on ADS granules, prevented the contact in between the plant extracts (dry form) and the taste buds due to insolubility of Eudragit E 100 in saliva. Although dissolution of ADS granules in stomach was not examined *in vitro* or *in vivo*, it appears that rapid dissolution would occur in GIT.

The relative density of alcoholic solution of Eudragit EPO was 0.811. Drennew *et al*, concluded that in-process weighing of known sample size/weight gain is the evaluation test that determines the coating process endpoint.<sup>18</sup> The weight gain for ADS coated granules was 4.76% w/w.

*In Process Quality Control (IPQC) Test on ADS coated granules*

The flow properties of ADS coated granules were studied for determination of endpoint of coating, in turn for standardization of coating. (Table 2) Adequate flow properties ensure uniform filling in the final container. According to angle of repose- compressibility- flowability correlation data, if angle of repose is 36-40°, it means passable flow property. If compressibility index and Hausner's ratio is 16-20 and 1.19-1.25 respectively, it means fair flow properties.<sup>8</sup> The flow properties of ADS coated granules were improved over uncoated ADS granules. The ADS coated granules complied with the limit for residual solvent.<sup>9</sup>

*Evaluation for Taste Masking*

The taste masking study in human volunteers of ADS powder, the uncoated and coated ADS granules revealed significant masking of the bitter taste of ADS powder.<sup>19</sup> The taste of ADS powder was reported as 'very bitter' by 5 volunteers and as 'bitter' by 1 volunteer on the perception scale. All the 6 volunteers reported the ADS coated granules as being 'good' on the perception scale whereas 4 volunteers reported ADS uncoated granules as 'bitter' and 2 volunteers reported as being 'very bitter' on the perception scale. Moreover all the volunteers experienced a good mouth feel of the ADS coated granules. Thus sensory evaluation indicated that coating with Eudragit E 100 significantly improved the palatability of ADS formulation.

**Highlights of Paper**

- The bitter taste of Ayurvedic dietary supplement was improved successfully with Eudragit E 100 as a coating agent and the pan coating process.
- Eudragit E 100 inhibited the contact in between the plant extracts and the taste buds due to insolubility of Eudragit E 100 in saliva.
- Sensory evaluation of taste indicated that the taste of coated granules was significantly masked.
- An attempt was made to standardize the pan coating process.

**Author Profile**

- **Dr. Alpana Kulkarni** is an Associate Professor at Department of Pharmaceutics, MAEER's Maharashtra Institute of Pharmacy, Pune. Her research interest is in the area of Dissolution method development and validation, Product and process optimization, Standardization of traditional medicines and cosmetics. She has 3 applied for 3 patents related to Aqueous coating composition with neem gum, Optimization of shodhana of guggul, in situ gel formulation of magnolol nanoparticles. She has worked on industrial projects related to taste masking of formulations, formulation development by spray drying.



- **Dr. Ajit Kolatkar** is an Ayurveda consultant in Pune since 17 years. He is the Director, Integrative Science division at AryaRasayan Bioresearch labs Llp a Research and development company dedicated to research in Ayurveda and traditional knowledge inspired product development. He also has developed a range of dietary supplement products which are presently successfully marketed and is a partner at NuHanceNutraceuticalsLlp.

**CONCLUSION**

In conclusion, we succeeded in masking the bitter taste and in improving the palatability of medicinal plant extract based dietary supplement. An attempt was made to standardize the pan coating method for a suitable dosage form, coated granules, consisting of herbal powders. The present work suggested that the use of sweeteners or other additives was not necessary for taste enhancement of ayurvedic nutraceutical formulation, especially for diabetic patients. The study would bring a paradigm shift in better compliance in users as well as better acceptance of ayurvedic dietary supplements by the nutraceutical industry. The preparation method designed in the present work is useful for masking the bitter taste of ayurvedic formulations.

**CONFLICTS OF INTERESTS**

The contributing authors do not have any conflicts of interest.

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## REFERENCES

1. Savarikar SS, Barbhind MM, Halde UK, Kulkarni AP. Pharmaceutical and analytical evaluation of triphala guggul kalpa tablets. *Journal of Ayurveda and Integrative Medicine* 2011; 2(1): 21-5.
2. Drewnowski A, Gomez-Carneros C. Bitter taste, phytonutrients, and the consumer: a review *Am J Clin Nutr* 2000; 72(6): 1424–35.
3. Sohi H, Sultana Y, Khar RK. Taste masking technologies in oral pharmaceuticals: recent developments and approaches. *Drug Development and Industrial Pharmacy* 2004; 30(5): 429–8.
4. Reilly WJ, editor. *Pharmaceutical necessities in Remington: The science and practice of pharmacy* 21st edition. New York: Mack Publishing Company; 2002; 711-14.
5. Wagh VD, Ghadlinge SV. Taste masking methods and techniques in oral pharmaceuticals: current perspectives *Journal of Pharmacy Research* 2009; 2(6): 1049-54.
6. Oppel K. Taste masking of an active pharmaceutical ingredient for veterinary application. PhD thesis, Faculty of Science, University of Basel, Basel, Switzerland; 2008.
7. Raymond CR, Paul JS, Sian CO. *Handbook of pharmaceutical excipients*. 5 th edition. London, UK: PhP Pharmaceutical Press; 2006.
8. US Pharmacopoeia 29, General Chapters: < 1174> Powder Flow. [cited 2013 Aug 25]; [about 2 pages]. Available from: [www.pharmacopeia.cn/v29240/usp29nf24s0\\_c1174.html](http://www.pharmacopeia.cn/v29240/usp29nf24s0_c1174.html)
9. Indian Pharmacopoeia. Volume I. Indian Pharmacopoeial Commission, Ministry of Health & Family Welfare, Government of India. 7<sup>th</sup> Edition; 2014; p162, 208, 225.
10. Ishkawa T, Watanabe Y, Utoguchi N, Mitsuo Matsumoto. Preparation and evaluation of tablets rapidly disintegrating in saliva containing bitter taste masked granules by the compression method *Chem Pharm Bull.* 1999; 47(10): 1451-54.
11. Cole GC. *Pharmaceutical Coating Technology*. UK: Taylor & Francis Ltd. 2002.
12. Mahamuni SB, Shahi SR, Shinde NV, Ararawal GR. Formulation evaluation of fast dissolving tablet of promethazine hydrochloride with masked bitter taste. *Int J Pharm Res Dev.* 2009; 1(5): 1-18.
13. US patent application publication 20060078614 A1 Gopi V. Taste masked pharmaceutical compositions.
14. Chapter 2 Solid dosage forms: powders and granules. [cited 2013 Aug 25]; [about 12 pages] Available from: [http://kinam.com/Lectures/363/2.%20Powders%20 & %20 Granules%20 Text.pdf](http://kinam.com/Lectures/363/2.%20Powders%20&%20Granules%20Text.pdf)
15. Harke group. Product catalog. Polyvinylpyrrolidone (PVP) for pharmaceutical applications. [cited 2013 Aug 25]; [about 2 pages]. Available from: <http://www.harke.com/products/synthetic-polymers/polyvinylpyrrolidone-pvp-for-pharmaceutical-applications.html>
16. ISP Chemicals. Product catalogue. PVP Poly vinyl pyrrolidone polymers. [cited 2013 Aug 25]; [about 15 pages]. Available from [http://www.brenntagsspecialties.com/en/downloads/Products/Multi\\_Market\\_Principals/Ashland/PVP\\_-\\_PVP\\_VA/PVP\\_Brochure.pdf](http://www.brenntagsspecialties.com/en/downloads/Products/Multi_Market_Principals/Ashland/PVP_-_PVP_VA/PVP_Brochure.pdf)
17. [parasshah.weebly.com/uploads/9/1/3/5/9135355/ipqc\\_\\_22.ppt](http://parasshah.weebly.com/uploads/9/1/3/5/9135355/ipqc__22.ppt)
18. Drenow J, Kirsch J. Determination of film-coated tablet parameters by near-infrared spectroscopy. *Journal of Pharmaceutical and Biomedical Analysis.* 1995; 13(2): 127.
19. Fu-de Cui, Gao Y, Guan Y, Yang L, Yong-sheng Wang, Li-na Zhang. Preparation of roxithromycin polymeric microspheres by the emulsion solvent diffusion method for taste masking. *Int. Journal of Pharma.* 2006; 318(1): 62-9.