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Innovative Technology for Preparing Value Added Product from *Mucuna Pruriens*

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***Abstract*:** Box-Behnken Design was used for conducting 29 experiments for preparing *Mucuna pruriens* seeds powder. The experimental data was analyzed by applying Response Surface Methodology (RSM) using Design Expert 12.0.8.0 software.The optimized values for soaking, boiling, autoclaving and drying were 9h, 30min, 20 min and 50°C, respectively were responsible for recovery of 87 per cent *M. Pruriens* seed powder. The L-Dopa value of 1.09 (g $100g^{-1}$) in *M. Pruriens* seed powder was considered safe for consumption. The sensory evaluation for overall acceptability for *M. Pruriens* seed powder was 7.2. The prepared *M. Pruriens* powder is a ready to eat value added product hence, it could be used for consumption by adding to liquids, milk, salads, curries, *etc*. The developed process technology for preparing *M. Pruriens* powder may be adapted by small, medium, and large-scale farmers, self-help groups, unemployed youths to become an entrepreneur.

Keywords: *Mucuna pruriens,* Value addition, Process, Drying, Powder recovery

The plant *Mucuna Pruriens* belongs to family "*Fabaceae*". It is widely known as "velvet bean" and mostly found in the form of a vigorous annual climber. It is originally from Southern China and Eastern India. It is considered as a viable source of dietary proteins due to its high nutritional value. According to Food and Agriculture Organization (FAO) it can be used to restore soil as well as to provide food. In Kenya it is generally grown to act as rehabilitating agent for deteriorated soils also to provide animal feeds as well as human food. *M. pruriens* seeds also possess the activity of different aliments of anabolic, androgenic, analgesic, anti-inflammatory, antispasmodic, antivenom, aphrodisiac, febrifuge, cholesterol lowering, hypoglycaemic, immune modulator, antilithiatic, antibacterial, antiparasitic, cough suppressant, blood purifier, carminative, hypotensive, and uterine stimulant properties (Divya et al 2017). It is one of the most important sources of L-dopa and thus increases the levels of dopamine in the brain hence it can be used very efficiently against Parkinson's Disease (Vaish et al 2014). It has become very necessary to diversify the present-day agriculture in order to meet various daily needs of human. The plants which remain ignored or under-utilized but have a tremendous potential for commercial exploitation, offer a good scope in this context. Processing of *M. Pruriens* bean increases its nutritional value and potential to improve food security. It is reported that there is a lack of data or knowledge about the nutritive value, various value-added products from *M. Pruriens*.

The research focuses on optimization of process parameters for preparing *M. pruriens* powder. Preparation of powder reduces the volume of seeds and helps in proper storage. The process parameters selected for preparing *M. Pruriens* powder helped in reducing the level of L-Dopa and by maintaining the other nutrients values of *M. Pruriens* powder. The prepared *M. pruriens* powder is ready to eat value added product, hence could be used for consumption by adding to liquids, milk, salads, curries.. Thus, to increase the awareness among the community about its medicinal benefits and to make *M. Pruriens* available in powder form, this work was proposed with the objectives to optimize process parameters for preparing *M. Pruriens* powder, quality analysis of *M. Pruriens* powder and to access economic feasibility of *M. Pruriens* powder.

MATERIAL AND METHODS

The present research work was carried out Agriculture Engineering and Technology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. *M. Pruriens* seeds were procured from Medicinal department of Nagarjun, Dr. P.D.K.V., Akola. The various process parameters like soaking (h), boiling (min), autoclaving (min) and drying (°C) were optimized for maximum powder recovery (%) and minimum powder loss (%) of *M. pruriens*. The process parameters for the preparation of *M. pruriens* seeds powder were analyzed by Response Surface Methodology (RSM) using Design-Expert software. Based on the preliminary experiments, Box

Behnken design was finalized for conducting 29 experiments with three level and four factor. The cleaned Mucuna seeds of 200g were used for each experiment.

Experimental design for preparation *M. pruriens* powder: The design of the experiments was based on the preliminary trials conducted. The three levels of the independent variables (Soaking in water (h), Boiling (min), Autoclaving (@1.05 kg/cm^2, 121°C) (min) and Drying (°C) were finalized based on the results of preliminary experiments. The finalized experiments along with four independent parameters and three levels for preparing *Mucuna pruriens* powder Table 1.

Response Parameters (Dependent variables)

Powder yield (%): Powder recovery was calculated as ratio of the weight of the powder produced to consume feed mixture on a dry basis and expressed as percentage yield.

$$\text{Powder yield (\%)} = \frac{\text{Mucuna powder yield (g)}}{\text{Mucuna seeds (g)}} \times 100$$

$$\text{Powder loss (\%)} = \frac{\text{Mucuna powder loss (g)}}{\text{Mucuna seeds (g)}} \times 100$$

Table 1. Independent variables for preparing *Mucuna pruriens* powder

Independent parameters	X_1	X_2	X_3
Soaking in water (h)	6	9	12
Boiling(min)	20	30	40
Autoclaving (@1.05 kg/cm^2,121°C) (min)	10	20	30
Drying (°C)	40	50	60

RESULTS AND DISCUSSION

Optimization of process parameters by using response surface methodology: The recovery of powder and powder loss were affected by process variables *viz.,* soaking (h), boiling (min), autoclaving (min) and drying (°C). To avoid bias, 29 runs were performed in a random order. Total 29 experiments (Table 2) generated through Box-Behnken design were conducted. The experimental data was analyzed by applying Response Surface Methodology (RSM) using Design Expert software. The process variables *viz.,* soaking (6, 9 and 12 h), boiling (20, 30 and 40 min), autoclaving (10, 20 and 30 min) and drying (40, 50 and 60°C) were finalized for maximum recovery of powder as well as for minimum powder loss. Models for the responses were developed through regression analysis.

The Model F-value of 41.73 implies that the model was significant (Table 3). There was only a 0.01% chance that an F-value. The P-values is less than 0.0500 indicate model terms were significant. In this case A, B, C, D, AB, AC, AD, BC, BD, CD, A^2, B^2, C^2, D^2 was significant model. Values greater than 0.1 indicate the model terms was not significant. There was a 13.89% chance that a Lack of Fit F-value is not significant. Non-significant lack of fit was good and thus, the model was fit for obtaining the response.

The R^2 value was computed by a least square technique and found to be 0.9766, showing good fit of model to the data. The predicted R^2 of 0.8762 was in reasonable agreement with the Adjusted R^2 of 0.9532 i.e. the difference was less than 0.2. Adeq. precision measures the signal to noise ratio. A ratio greater than 4 was desirable. Ratio of 10.2520 indicated an adequate signal. So this model was used to navigate the design space. The recovery of powder was prominently affected by soaking (h), boiling (min), autoclaving (min) and drying (°C) (Fig 1). Drying at 50°C plays an important role as the proper drying helps to get maximum recovery of powder with less losses. The soaking of 6h is sufficient to get maximum recovery of powder with minimum losses. It was observed that, the autoclaving for 22 min and boiling for 23 min were best combination for getting maximum recovery of powder.

The loss of powder (%) of Mucuna seeds ranged between 13 to 26% within the combination of variable studied (Fig. 2). It was revealed, that the minimum loss of powder i.e. 13% was obtained with treatment having the combination of soaking in water for 6h, Boiling for 20 min, autoclaving for 20 min and drying at 50°C. Thus the minimum loss of powder were found to be dependent on process parameters viz., Soaking in water (hr), Boiling (min), Autoclaving (min) and Drying (°C).

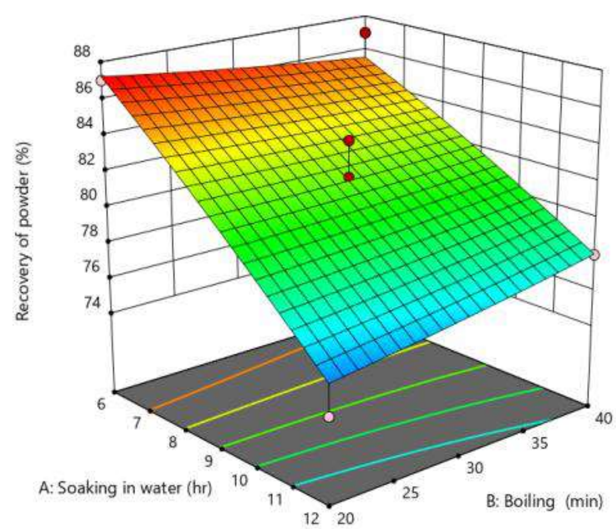


Fig. 1. Effect of boiling (B) and soaking in water (S) on recovery of powder at constant autoclaving (A= 20 min) and drying (D = 50°C)

Optimization of different process input variables for preparation *M. pruriense* powder: Numerical multi response optimization technique was carried out for the operational parameters for the preparation of Mucuna seeds powder. To perform this operation, Design Expert software of the STAT-EASE software (Statease Inc, Minneapolis, USA Trial version), was used for simultaneous optimization of the multiple responses. A stationary point at which the slope of the response surface was zero in all the direction was calculated by partially differentiating the model with respect to each variable, equating these derivatives to zero and simultaneously solving the resulting equations, thus simultaneously optimizing the multiple responses. The desirability values with optimum combinations of independent variables *viz.,* soaking (h), boiling (min), autoclaving (min) and drying (°C) and response parameter for maximum value of recovery of powder and minimum value of loss of powder were graphically presented from Figure 1 to 2 Table 2 shows that the software generated anoptimum conditions of independent variable with predicted values of responses. The solutions given in Table 5 having the maximum desirability value 1 was selected as the optimum condition for preparation of Mucuna seed powder.

Quality parameters: Average values of L-Dopa content (%) for raw and optimize Mucuna seed powder content (g $100g^{-1}$) for raw and experimentally optimized sample were 4.79 and 1.09 g 100 g^{-1}. Sensory evaluation of raw and optimized *M. pruriense* seed powder

The raw sample powder and experimentally optimized powder sample was tasted by 10 panelists with

Table 2. Recovery of powder under varying process parameters

Exp No.	Soaking in water (h)	Boiling (min)	Autoclaving (min)	Drying (°C)	Recovery of powder (%)
1	12	30	30	50	76
2	12	30	20	40	77
3	6	40	20	50	86
4	9	30	30	40	80
5	12	30	10	50	78
6	9	30	20	50	82
7	9	30	10	60	79
8	9	20	20	60	80
9	9	40	20	40	78
10	9	30	30	60	79
11	9	30	20	50	80
12	6	20	20	50	87
13	9	20	10	50	82
14	12	20	20	50	74
15	12	30	20	60	75
16	9	40	10	50	84
17	6	30	20	60	85
18	9	20	30	50	80
19	9	30	10	40	83
20	6	30	30	50	86
21	9	30	20	50	84
22	9	30	20	50	84
23	9	40	20	60	81
24	9	20	20	40	84
25	9	40	30	50	81
26	6	30	10	50	85
27	6	30	20	40	85
28	9	30	20	50	79
29	12	40	20	50	78

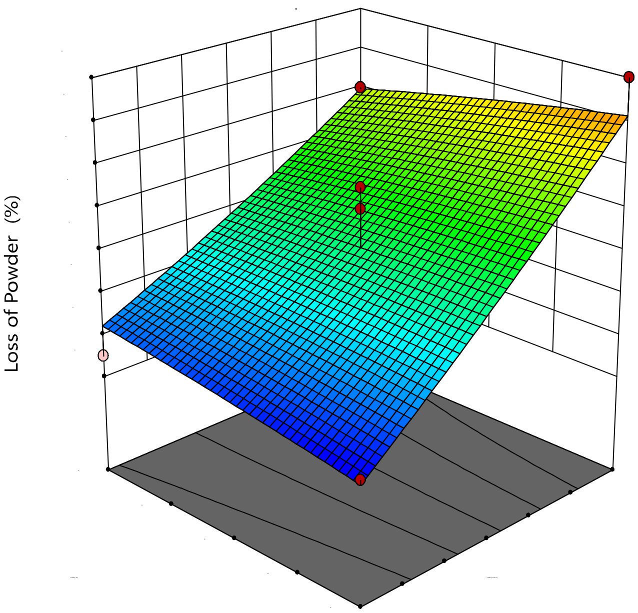
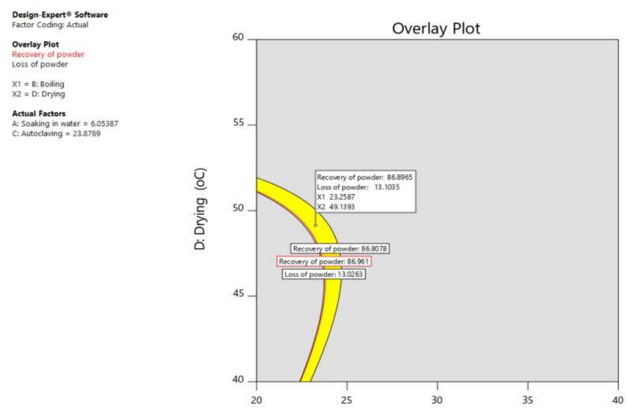


Fig. 2. Effect of soaking in water (S) and boiling (B) on loss of powder at constant autoclaving (A = 20 min) and drying (D = 50°C)

the help of 9-point Hedonic test chart overall acceptability values of raw powder sample and experimentally optimized powder sample were 7.4 and 7.2.



Soaking in water (h) = 6.09 ~ 6
Boiling (min) = 23.26 ~ 23
Autoclaving (min) = 21.84 ~ 22
Drying (°C) = 49.13 ~ 50

Fig. 3. Effect of boiling (B) and drying (D) on responses

Table 3. Analysis of Variance (ANOVA) showing the effect of process parameters on recovery of powder

Source	Sum of squares	Df	Mean square	F-value	p-value	
Model	446.54	14	31.90	41.73	< 0.0001	Significant
A-Soaking in water	80.08	1	80.08	104.78	< 0.0001	
B-Boiling	14.08	1	14.08	18.43	0.0007	
C-Autoclaving	10.08	1	10.08	13.19	0.0027	
D-Drying	10.08	1	10.08	13.19	0.0027	
AB	12.25	1	12.25	16.03	0.0013	
AC	9.00	1	9.00	11.78	0.0041	
AD	16.00	1	16.00	20.93	0.0004	
BC	6.25	1	6.25	8.18	0.0126	
BD	56.25	1	56.25	73.60	< 0.0001	
CD	1.0000	1	1.0000	1.31	0.0719	
A^2	138.25	1	138.25	180.89	< 0.0001	
B^2	53.30	1	53.30	69.74	< 0.0001	
C^2	44.41	1	44.41	58.11	< 0.0001	
D^2	109.93	1	109.93	143.83	< 0.0001	
Residual	10.70	14	0.7643			
Lack of fit	9.50	10	0.9500	3.17	0.1389	Not significant
Pure error	1.20	4	0.3000			
Cor total	457.24	28				
Std. Dev.	0.8742		R^2	0.9766		
Mean	86.52		Adjusted R^2	0.9532		
C.V. %	1.01		Predicted R^2	0.8762		
			Adeq. Precision	10.2520		

Table 4. Optimized solution generated by the software

Soaking in water (h)	Boiling (min)	Autoclaving (min)	Drying (°C)	Recovery of powder	Loss of powder	Desirability	Remarks
6.02	20.17	19.99	50.70	87.02	12.98	0.890	Selected
6.05	20.38	13.01	47.35	87.34	12.66	0.830	
6.08	23.37	15.42	44.58	87.20	12.81	0.879	
6.05	20.59	23.88	50.33	87.05	12.96	0.860	
6.02	23.09	21.66	45.04	87.24	12.76	0.872	

CONCLUSION

The optimized values for soaking, boiling, autoclaving and drying were 9h, 30min, 20 min and 50°C were responsible for recovery of 87% Mucuna seed powder. The L-Dopavalue of 1.09 (g $100g^{-1}$) in Mucuna seed powder was considered safe for consumption. The sensory evaluation for overall acceptability for Mucuna seed powder was 7.2.

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