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# Applications of Response Surface Methodology in the Food Science and Technology

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## INTRODUCTION

Response surface methodology (RSM), an experimental approach first created and defined by Box and Wilson (1951), has been applied with great success in a variety of contexts, particularly in the disciplines of chemistry and chemical engineering. RSM is generally a good strategy and is frequently used to improve food industry processes.

RSM is a collection of mathematical and statistical methods founded on fitting empirical models to experimental data obtained in accordance with experimental design. In order to achieve this goal, the system under study is described using linear or square polynomial functions, which are then used to investigate (by modeling and displacing) the experimental conditions up until the system is optimized (Teo´filo, 2006).

The following are some steps in the use of RSM as an optimization technique (Bezerra et al. 2006): (1) the choice of the experimental design and execution of the experiments in accordance with the chosen experimental matrix; (2) the mathematic-statistical treatment of the obtained experimental data through the fitting of a polynomial function; (3) the delimitation of the experimental region and selection of independent variables of major effects on the system through screening studies; (4) The model's fitness is assessed; (5) The necessity and viability of conducting a displacement in the direction of the optimal region are confirmed; (6) The best values for each examined variable are obtained.

### Theory

Granato and de Araújo Calado (2013) stated that a response variable (y) and a number of associated control variables, denoted by $x_1$, $x_2$,..., $x_k$, are developed into an adequate functional relationship using a variety of mathematical and statistical methods known as RSM.

In general, such a relationship is unknown but can be approximated by a low-degree polynomial model of the form

$$y = f(x)\beta + e$$

where $x = (x_1, x_2, \ldots, x_k)'$, f(x) is a vector function of p elements that consists of powers and cross products of powers of $x_1, x_2, \ldots, x_k$ up to a certain degree denoted by d ($\geq 1$), β is a vector of p unknown constant coefficients referred to as parameters and e is a random experimental error assumed to have a zero mean. This is conditional on the belief that a model, which must be significant statistically, provides a suitable representation of the response and the lack of fit is not significant ($p<0.05$) (Khuri and Mukhopadhyay, 2010).

Experimental data are fitted using straightforward mathematical models. To adequately represent sensory, biochemical, physical, and physicochemical data, linear and quadratic models are typically suitable (Dutcosky et al., 2006; Capitani et al., 2009; Farris and Piergiovanni, 2009).

## Application of RSM to Food Science and Technology

**Table 1: Some application of RSM on different process**

| S.No. | Process | Application |
|---|---|---|
| 1. | Food Waste Processing | Shukla and Neelancherry (2022) investigated that raw and processed data set for optimization of bio-oil production from microwave co-pyrolysis of food waste and low-density polyethylene with RSM. |
| 2. | Food Nutrition | Mehmood (2021) studied the optimisation of food grade mixed surfactant-based l-ascorbic acid nanoemulsions using RSM. |
| 3. | Food Formulation | Razjoo et al. (2021) researched the effect of Amygdalus scoparia Spach and Lepidium sativum L. seed gums on the properties of formulated food supplement for soldiers using RSM. |
| 4. | Food Extraction Process | Altunay et al. (2021) analysed optimization of an ultrasound-assisted alcohol-based deep eutectic solvent dispersive liquid-phase microextraction for separation and preconcentration of quercetin in wine and food samples with RSM. |
| 5. | Food Packaging | Maleki and Mohsenzadeh applied RSM to optimized of a biodegradable packaging film based on carboxymethyl cellulose and Persian gum containing titanium dioxide nanoparticles and Foeniculum vulgare essential oil. |
| 6. | Food Drying Process | Kaweh et al. (2022) used of ultrasound pre-treatment before microwave drying of kiwifruits – an optimization approach with RSM. |
| 7. | Food Drying Process | Bchir et al. studied the optimization of ultrasound-assisted osmotic dehydration of pomegranate seeds (Punica granatum L.) using RSM. |
| 8. | Pharma-ceutical Industry | Gaikwad et al. studied the process optimization by RSM for microencapsulation of pomegranate seed oil. |

## CONCLUSION

The advantages of response surface methodology over traditional one-variable-at-a-time optimization, such as the generation of large amounts of information from a small number of experiments and the ability to evaluate the interaction effect between the variables on the response, have led to its widespread and consolidated use in the optimisation of analytical procedures today. Choosing an experimental design, fitting an appropriate mathematical function, and

assessing the fitted model's quality and accuracy to make predictions in relation to the experimental data gathered are all required before using this technique for experimental optimisation.

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