Research Article
The Study on Food Sensory Evaluation based on Particle Swarm Optimization Algorithm

Hairong Wang and Huijuan Xu
Huanghuai University, Henan, China

Abstract: In this study, it explores the procedures and methods of the system for establishing food sensory evaluation based on particle swarm optimization algorithm, by means of explaining the interpretation of sensory evaluation and sensory analysis, combined with the applying situation of sensory evaluation in food industry.

Keywords: Food industry, food sensory evaluation, particle swarm optimization algorithm

INTRODUCTION

People pay more attention to food quality inspection and quality control with increasing life quality. The detection methods for food quality are required to be not only accurate and objective, but also rapid and convenient. Thus, it may be very important to introduce new detection means and investigate their feasibility in food quality inspection and quality control. Food sensory science is a discipline which systematically studies the forms of interaction as well as rules between human senses and food, its core is the quality of sensory food, while its basic scientific method is sensory evaluation (Toko, 2000). Sensory evaluation is a scientific method, which is used to evoke, measure, analyze and interpret products through the reaction of vision, smell, touch, tasting and hearing. Modern sensory evaluation theory is developed based on psychology, physiology and statistics and so on. As shown in Table 1.

It is a set of sensory method for the analysis and design, which is through the organs of human senses to detect the characteristics and the quality of the products, so as to obtain accurate and reliable data and conclusions. With the help of the eyes, nose, mouth, tongue, hands and ears, plus the combination of psychology, physiology, physics, chemistry and statistics and other subjects, making measurement and analysis on the qualitative and quantitative of the food, so as to understand the characteristics of the product itself and further understand the product acceptance of consumers, as well as the favorite degree of the products.

MATERIALS AND METHODS

Sel PSO and solution of the nonlinear equations:
Sel PSO: Particle Swarm Optimization algorithm (PSO), found by Kennedy and Eberhart (1995), is a kind of intelligent optimization algorithm originated from the study of birds seeking food and then in order to promote the explorations in early optimization stages, the inertia weight w is introduced into PSO (Foley *et al*., 2002). Owing to its simple structure, PSO is developing rapidly and has plenty of modified forms, which is easy to understand and use (Das *et al*., 2008). A modified PSO brought forward by Shi are as follows:

$$v_i^{k+1} = wv_i^k + c_1r_1\left(pbest_i^k - x_i^k\right) + c_2r_2\left(gbest_i^k - x_i^k\right) \quad (1)$$

$$x_i^{k+1} = x_i^k + v_i^{k+1} \quad (2)$$

where, Eq. (1) is to calculate the new velocity and Eq. (2) is to calculate the new position; v represents the velocity and x represents the position; w is the inertia weight; i is the ith particle and k is the kth generation; c1 and c_2 denote weighing factors called accelerated coefficients; r_1 and r_2 are random variables uniformly distributed within [0, 1]; $pbest_i$ denotes the ith personal best fitness and $gbest_i$ denotes the ith global best fitness; the initial velocity and position of each particle are random variables generated by the standard normal distribution.

The natural selection-based particular swarm optimization algorithm is a combination of the particle swarm optimization algorithm and the theory of natural selection, which can obtain precise solutions. In every iteration, this method ranks particles according to the fitness value G, the worse half of which are replaced by the better half and in the meantime, the *pbest* of each particle and the *gbest* are kept to go on the next iteration. In addition, the initial positions can be roughly selected according to practical requirement and neglect iterations followed if the fitness value *G* meets the standard (such as G<R), which improves calculation effectives. Thus the modified natural selection-based

Table 1: The classification of human feelings

| Species	Organs	The adapting stimulus	The source of stimulus
Vision	Eyes	Light	Color
			Position
			Shape
Touching	The skin and subcutaneous tissue	Direct and indirect contact	Touch
			Pressure
			Temperature
Hearing	Ears	Voice	Tone
			Rhythm
Smelling	Olfactory cells in nasal cavity	The volatile substances	Smell
Tasting	Tongue and mouth	The surface of contacting	All kinds of taste
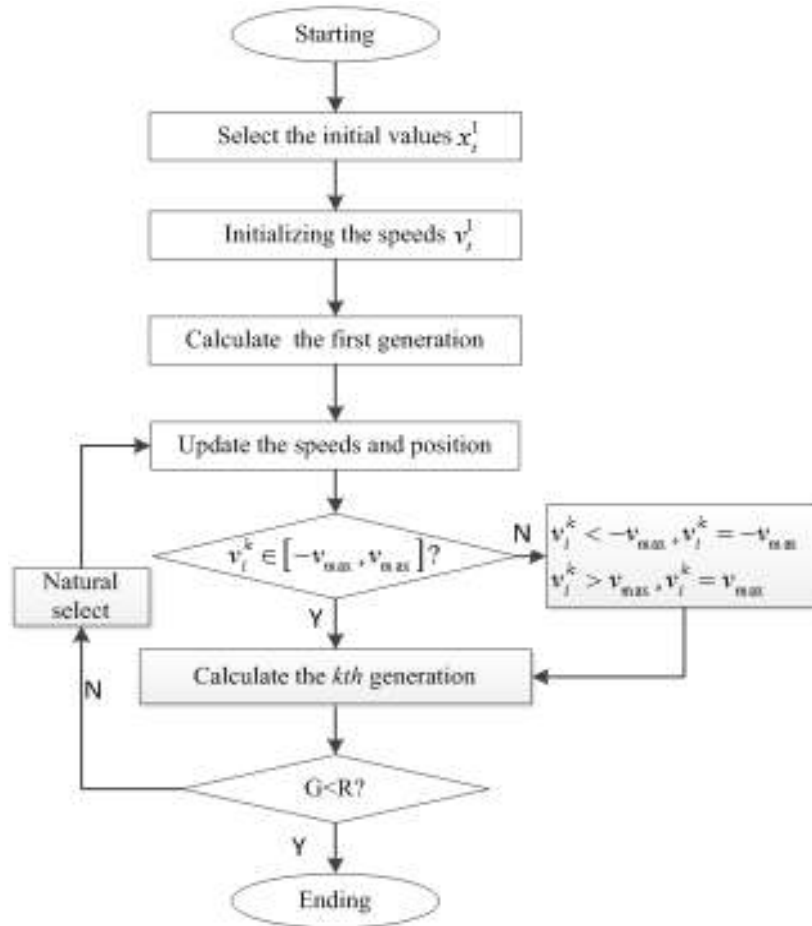
Fig. 1: Calculation flow chart of selPSO

particle swarm optimization algorithm is obtained, the flow of which is shown in Fig. 1.

The solving of the nonlinear equations: In the operation of the mechanism, variables are unpredictable owing to that they vary with the time and motion. Meanwhile, the convergence, convergence velocity and performance characteristics are highly sensitive to the initial value, which leads to difficulties when adopting most numerical methods. Aiming at this problem, sel PSO, which can overcome the problem of high sensitivity to the initial value, is employed to solve the systems of nonlinear equations.

A system of the linear equations is as follows:

$$F(x) = \left[f_1(x), f_2(x), f_3(x), L f_n(x) \right]^T = 0 \tag{3}$$

where, $x = (x_1, x_2, x_3, \ldots x_n)^T$ are the n variables. Set the fitness value G:

$$G = \left| f_1(x) \right| + \left| f_2(x) \right| + \left| f_3(x) \right| + \cdots + \left| f_n(x) \right| \tag{4}$$

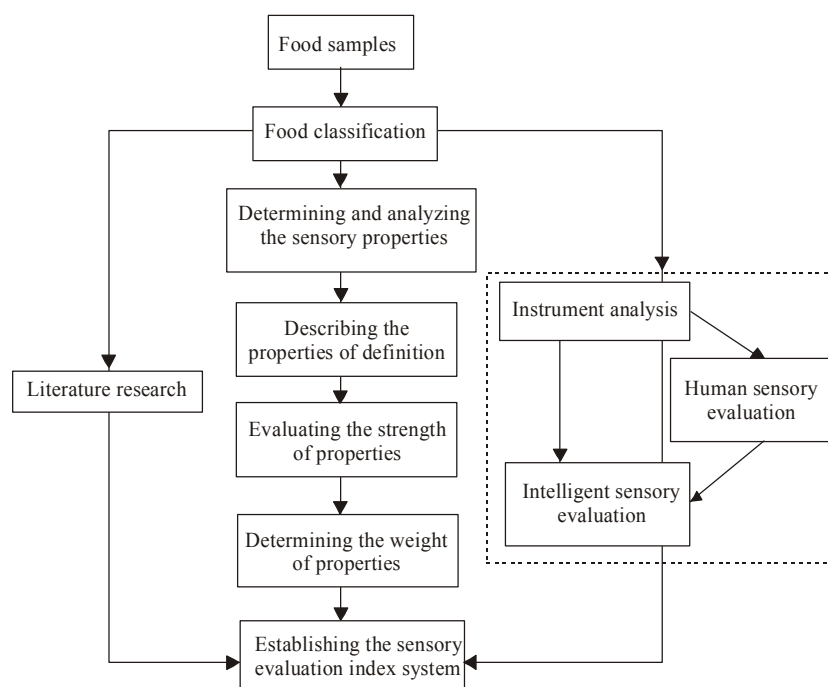Then solve the system of nonlinear equations with sel PSO.

Fig. 2: Food sensory evaluation system

Differential method: This kind of method is different from the testing method or a simple differential method. It is mainly used to evaluate the existence of sensory differences between a series of products and different batch during the production process, distinguishing the difference in size (Cai *et al*., 2006). This is a method that is often used during the production process of controlling the quality of the products.

Method of description: It is mainly about the inspection method of product sensory properties with the perceived intensity as well as quantization, which requests the assessors to evaluate on each index of the samples with the characteristics that are described qualitatively, describing the quality of the products as completed as possible. These methods are mainly descriptive analysis, such as: flavor profile method, quantitative descriptive analysis method, spectral method.

Hobby method: It is mainly a method to quantify the degree of the likes and dislikes of products. Relying on the comprehensive feelings both physically and mentally, which can play a decisive role in the degree of human feeling as well as the subjective judgment (Ampuero and Bosset, 2003).

The present application of sensory evaluation in food industry: With the improvement of life level, the requirements of people on food are increasingly higher and higher, which puts forward higher request on the food sensory evaluation. Because there is any devices that can replace the brain and the sensory feeling of human, therefore, the sensory evaluation is applied more and more widely, which has become an indispensable means of quality inspection in the food industry. It can reduce the risk of the enterprises in the production process, which can provide the enterprises for with the related information for the new development, improvement, component replacement, market forecast, quality control of thee products.

At present, the sensory evaluation in the world is developed at fast speed, in the United States, each big food companies (such as Coca-Cola, Nestle, etc.) has large sensory evaluation departments, Departments of Food and Science of all the universities are established with sensory tasting researching field and industry, in the United States, there is even appeared a lot of sensory evaluation professional Consultants Companies, which can provide critical services for small and medium size enterprises.

The procedure and method of establishing the evaluation index system of food sensory: By analysis, the establishment of index system of food sensory evaluation procedures, as shown in Fig. 2.

First of all, it should classify the food samples and then determine and analyze the sensory properties of the food. Choosing the word to describe the sensory properties with words or terms that are related to define the description of the products, moreover, it can use suitable scaling to evaluate the sensory properties, so as to determine the weight of various sensory properties, as well as its proportion of the overall evaluation. Finally, it can establish up food sensory evaluation index system through the literature and the experimental studies.

The procedures and methods of the index system of food sensory evaluation:
The classification of food: Because the sensory characteristics of different types of food is quite different, before setting up the index sensory evaluation system, it should firstly conduct a scientific and rational classification, then according to the different types of food, using different evaluating index system as well as different methods. For example: food processing can generally be divided into twenty two categories. Among them, according to the raw materials of the food sources it can be divided into ten categories: cereal products, bean products, potato products, fruit products, vegetables, meat products, egg products, dairy products, aquatic products and bee products; besides, it can be divided into nine major categories according to the processing properties of food: edible starch and starch products, edible fats, sugar, candy, chocolate and chocolate products, drinks, wine, frozen drinks, seasoning, special dietary food and so on.

Selecting and determining the sensory properties of the food: Any kind of food sensory qualities can be characterized and defined by multiple sensory index. Sensory index of the products is mainly related to the properties, characteristics, description (term), strength, etc., (Matín *et al*., 1999). In the aspect of feature and qualitative, the selection of the sensory characteristics as well as the corresponding definition should be linked with the chemical and physical characteristics, which can make the product sensory index formulation and physicochemical indexes be associated with each other, as well as mutually explanatory and supplementary. It can refer to the relevant international standards, national standards and more authoritative researching results.

RESULTS AND DISCUSSION

Selecting the descriptive words or terms to describe the sensory properties: In sensory evaluation, after determining the sensory properties of foods, it must choose or establish some related terms or descriptors to describe two specific situations:

- The word or term is existed in the existing standards or the other authority literature, there are provisions for the related terms and describe the words with the sensory characteristics of the food, which can be directly choose.
- In the existing standards or other authority of the literature, there is no relevant terms and descriptive words to describe the sensory characteristics of the food, which should be selected and defined by the standard method or scientific standard to define the description of the words and the related terms.

Adopting suitable scale to evaluate the sensory characteristics: Determining the related terms or descriptive words, it should use the suitable scale to evaluate the products as well as the sensory properties, such as using the national standard GB/T 16290-1996 Sensory Analysis-Methodology: Using Scale to Evaluate Food. This standard defined various testing methods by using several types of scaling for the sensory evaluation of the products.

Determining the weight of the sensory properties: At present, there is no standard method to determine the weight of sensory properties or the proportion of the sensory index in the overall evaluation. Generally, it can test the consumer's preferences through the study or survey on consumers with the certain types of food, color, smell, taste, shape and other sensory characteristics, as well as the statistical analysis, so as to determine the properties. It also can be through the expert to make assessment with the statistical significance of the food as well as the characteristics, using fuzzy mathematics method to determine the weight.

Constructing the sensory index system: As for the determined sensory index of all foods, it should construct an organic whole according to certain rules as well as the inner relationship to form the sensory index system.

CONCLUSION

In conclusion, the establishment of the index system of food sensory evaluation needs to do a lot of basic research, so as to better define and evaluate the sensory properties of the foods. Using the application of physiology, psychology, statistics and fuzzy mathematics as the tools, can establish a clear and reliable qualitative and quantitative evaluation system, which can set up a more practical and comprehensive index system of food sensory evaluation.

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