Evaluation of nutritional and sensorial quality in meal production – NSQE system

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Abstract

In this study, a programme for monitoring critical control points was developed, based on the hazard analysis critical control point (HACCP), in order to determine the nutritional and sensorial quality of menu components in foodservice. A case study was carried out in a foodservice unit where the principles of the HACCP system were implemented. Data were collected during the monitoring of the operational process of the meat-based menu components through measurements, records and comparisons with previously defined nutritional and sensorial criteria. Nutritional and sensorial hazards were highlighted for the monitored operational stages, along with the critical limits and the form of monitoring. Possible corrective actions were also noted and indicated that they should be adapted to meet each foodservice unit's situation. Through the application of the proposed theoretical model, the possibility for associating the hygiene–sanitary control and the nutritional and sensorial control analyses was noted.

Introduction

The importance of food for human survival is undeniable. Scholars agree that attaining good health through eating involves consuming an adequate, nutritionally balanced diet that includes a variety of foods that provide the energy and nutrients necessary for the good functioning of the organism (Panagiotakos *et al.* 2003; Chahoud *et al.* 2004; Donaldson 2004; Kearney *et al.* 2005).

Above everything else, however, eating is an act of pleasure and therefore goes beyond survival or the manifestation of basic rituals that support cultural behaviour in family and social contexts (Poulain 2002; Germov & Williams 2003). This idea is reaffirmed when we consider that the act of eating is directly related to the various sensory organs that do or do not offer agreeable sensations, depending on the impression that they give to the taster. It is also important to consider that in the pleasure of eating the sensation of well-being is involved and is associated with the act of recovering losses and prolonging human existence (Brillat-Savarin 2000).

It is also possible to observe that the increased practice of eating meals outside the home and other changes in social context induce modifications in feeding habits. These conditions enhance the importance of foodservice, given its responsibility for supplying adequate meals and its influence on the feeding behaviour of people through food and nutrition education.

However, a constant concern is the perception that when discussing the quality of food supplies a supervalorization regarding hygiene–sanitary quality is occurring throughout the world (Proença 1996, 1997, 2000). Authors such as Lagrange (1995) and Poulain (2002) note that food quality may be perceived by human beings in multiple dimensions. Therefore, it seems somewhat inadequate for those seeking assurances or developing methodologies for gauging quality to report only one of these dimensions – whether or not the food is clean and not contaminated. It is as if this dimension guarantees that all other dimensions are satisfactory as well.

An analysis of the current scientific literature in the area demonstrates that concerns regarding process quality also include, primarily, hygiene–sanitary quality (Farrar 2003; Walker *et al*. 2003; Herrera 2004; Legnani *et al*. 2004; Moreira *et al*. 2005; Sun & Ockerman 2005). The hazard analysis critical control point (HACCP) methodology, which aims to identify the hazards associated with all food production, processing and distribution stages, has been widely employed for hygiene–sanitary quality control (Bryan 1992; Seward 2000; Worsfold 2001; Billy 2002; Hulebak & Schlosser 2002).

Similarly, studies have shown that scientific evidence of food value alone is not strong enough to prompt changes in eating habits (Rozin *et al*. 1999; Rozin *et al*. 2004). Many other physical and psychological factors inherent to individuals and their environment (social, economic, cultural) may also motivate changes in their eating habits. Furthermore, sensorial qualities such as taste, smell, texture and appearance are also determining factors in people's eating behaviour and choices and undoubtedly contribute to the ingestion, satiation and selection of foods in a meal (De Assis *et al*. 2003; Savic-Berglund & James 2004; Wardle *et al*. 2004; Bellisle 2005).

This highlights one of the greater challenges facing nutritionists, i.e. not only considering the quantitative aspects of foods as they relate to nutrients or microbiological safety, but also considering preparation techniques that bring together health and pleasure at the same time when planning menus. In this regard, planning pleasurable and nutritionally balanced menus may represent a valuable tool in the building of healthy eating habits. However, it is also necessary to change the planning, recorded on paper, in order to produce a meal that the consumer will perceive as delicious and adequate. According to the basic principles of nutrition, the transformation of the idealized meal into such an appetizing meal requires the use of instruments of control.

Given this context, a theoretical model of the productive process control for monitoring the nutritional and sensorial quality of meat-based menu components – the nutritional and sensorial quality evaluation (NSQE) method – was conceived and applied in conjunction with the HACCP system (Riekes 2004; Proença *et al*. 2005). The NSQE method considers the nutritional and sensorial hazards that are present in the process of preparing meals and proposes actions to minimize their negative effects.

Nutritional hazards are those that result in the loss or reduction in the nutritional value of a food because of inadequate preparation techniques or other inadequate procedures in the preparation process. Examples include (i) a reduction in the content of iron and vitamins in meat because it was immersed in water without protective packaging to defrosting; (ii) failure to reduce the saturated fat content of a product by removing its visible fat (e.g. chicken skin); and (iii) greater lipid oxidation as a result of cooking at high temperatures (Riekes 2004; Proença *et al*. 2005).

Sensorial hazards are those that adversely affect the sensorial aspects of a food because of inadequate preparation techniques or other inadequate procedures used in the preparation process. Examples include (i) a reduction in flavour and a loss of tenderness in meat because it was immersed in water without protective packaging to defrosting; (ii) the use of elements very rich in fat that adversely affect a food's appearance and flavours from other foods; and (iii) the 'drying out' (dehydration) of foods and the continuing of the lipid oxidation process when foods are kept warm at high temperatures while waiting to be distributed (Riekes 2004; Proença *et al*. 2005).

The NSQE theoretical model recognizes that the search for quality means, primarily, periodically verifying items and maintaining records of data inherent to the process. As a result, it is possible to implement corrective actions and attempt to control the nutritional and sensorial hazards whenever a quality criterion is not being fulfilled (Riekes 2004; Proença *et al*. 2005).

The objective of this study is to develop an instrument for evaluating nutritional and sensorial quality by observing, monitoring and recording the entire meat-based preparation process. The criteria for analysing other large-meal menu items within the NSQE system are under development.

Materials and methods

The study was carried out using meat-based menu components, with particular emphasis on those offered with the most frequency on menus of a foodservice unit in which the principles of the HACCP system have been applied.

The following instruments were used in the application of the proposed model methodology:

- Photographic camera;
- Calibrated digital thermometer with a stainless insertion rod that evaluates temperatures between –50°C and +150°C (model DT-625, Dellt, São Paulo, Brazil);
- Calibrated infrared thermometer, which is able to monitor temperatures between –20°C and +315°C (model SK-8700, SATO KEIRYOKI MFG. CO. LTDA®, São Paulo, Brazil);
- Calibrated precision scale with a maximum capacity of 5000 g, subdivided into 1 g (model LS 5000, Ohaus®, São Paulo, Brazil);
- Salt Detector® (model-3011, TBW, São Paulo, Brazil), which is able to indicate the salinity level of the menu components rapidly;
- Strips for the colometric test. The strips, named Low Scale Oils and Fats Monitor (São Paulo, Brazil), have four blue bands, which indicate the degree of fat breakdown. As the colour of the strips changes to yellow, the per cent concentration of free fatty acids is indicated. The higher the number of yellow bands on the strips, the greater the concentration of free fatty acids;
- Data recording forms.

Ten components from the menu were chosen for evaluation: steak in gravy; grilled steak; beef escalope with lemon; stewed beef; cooked kobe; pork leg steak with onion; meat and bean stew; chicken breast in wine; baked chicken; and Fish Vera Cruz. These selections were chosen based on their distinct forms of preparation, including preparation in a conventional electric oven, on a gas griddle (on the stove), on electric equipment; total immersion in soya oil, in an electric fryer and sauced dishes prepared on the stove. Meats used included poultry, beef, pork and fish.

Data were collected by monitoring and measuring the operational process, recording the measurements and comparing them with defined criteria based on theoretical references and observational analyses.

Results and discussion

By conducting a literature search, it was possible to define the theoretical criteria for nutritional and sensorial quality and design forms for evaluating the preparation of collective meals.

The following summarizes the stages of the process:

- The nutritional and sensorial quality evaluation rota, which evaluates the various operational procedures, was applied at each stage of the production process (from delivery to distribution) according to the defined nutritional and sensorial quality criteria.
- A detailed description of preparation was also applied at each stage. It included a description of all of the ingredients and their quantities; the mode of preparation, including materials and utensils required and information regarding time and temperature; specifications for desired sensorial characteristics; definitions of notable nutritional aspects; as well as a photographic depiction of the preparation.
- A preparation flowchart was designed, providing a graphic presentation of the stages comprising the process and highlighting the critical control points related to the nutritional and sensorial aspects which must be indicated at each stage of the process.
- A descriptive table, which accompanies the flowchart and highlights the stages, hazards, criteria, form of monitoring, corrective actions and latest evaluation records, was prepared to indicate whether or not criteria were being met.

The results were based on observations and data recorded regarding the preparation process that was carried out, seeking to highlight those that are the most significant, addressing aspects related to the process as a whole and considering all aspects of the process – from the selection of

Table 1 Summary table of hazards and critical control points associated with the elaboration process of meat-based menu components related to the nutritional and sensorial quality evaluation

Order	Stage/ Operation	Control method	Actions	Effects	Consequences for the nutritional and sensorial quality
1	Receival	Control card, infrared thermometer, comparison with the photographic record that defines the identification and quality standard	Immediate return of the nonconforming product	Avoids the possibility for the use of products that do not fulfil quality specifications	Allows that the process begins with the use of products with a predefined quality.
2	Pre-preparation	Control card, infrared thermometer	Defrost under a controlled temperature between 4°C and 5°C	Avoids: • loss of iron; • loss of water of protein molecules; • the formation of ice crystals, which makes the reabsorption of water impossible	Preserves the iron and water-soluble nutrients. Avoids protein denaturation. Preserves the texture, flavour and aroma.
3	Pre-preparation	Control card, infrared thermometer	Defrost at ambient temperature	Causes greater weight loss due to the loss of liquids	Exerts a negative impact on the cost of the meal, hindering the implantation of improvements to the menus.
4	Pre-preparation	GHP	Remove visible fat	Reduces the saturated fat content	Enhances the nutritional quality and seeks to maintain the sensorial quality.
5	Pre-preparation	Control card, digital scale, monthly procedure	Standardize the meat cuts	Allows appropriate nutritional characteristics and administration, and allows process to be carried out as planned	Achieves the nutritional recommendations.
6	Pre-preparation	GHP	Marinate with wine	Gives flavour and also tenderizes the meat through acidification of the medium	Gives the desired sensorial aspects.

Table 1 *Continued*

Order	Stage/ Operation	Control method	Actions	Effects	Consequences for the nutritional and sensorial quality
7	Pre-preparation	GHP	Employ: • mechanical action (mince, chop, beat); • enzymatic action (papain, bromelain); • chemical action (garlic wine marinade, salt)	Causes: • physical destruction for tenderizing; • deorganization of the structure of muscle fibres; • protein hydrolysis; • protein hydration	Tenderizes the meats.
8	Pre-preparation	GHP	Use herb and spice infusions, preferably in an acid medium, with additional salt	Gives agreeable flavour to the preparation Reduces the risks of contamination by herbs	Increases sources of micronutrients and antioxidant elements, enhances the nutritional and sensorial quality.
9	Pre-preparation	GHP	Use herbs and spices: rosemary, sage, thyme and oregano, without submitting them to excessive heat (volatile elements)	Gives agreeable flavour to the preparation Exerts antioxidant activity	Enhances the nutritional and sensorial quality.
10	Preparation	GHP	Apply thermal treatment	Triggers the Maillard reaction Converts collagen to gelatin Causes protein denaturation Forms toxic compounds such as malonaldehyde (MDA) Causes lipid oxidation (LO) Causes the thermal degradation of organic material	Verifies the presence of colouring, antioxidant products and aromatic compounds. Tenderizes. Renders the foodstuffs assimilable. Shows toxic, atherogenic and carcinogenic activity. Causes changes in meat colour. Converts oxymyoglobin into metmyoglobin.
11	Preparation	Control card, insertion thermometer	Sauce Cook at high humidity (70°C–75°C)	Causes the solubilization of collagen	Tenderizes the meats.
12	Preparation	Control card, insertion thermometer	Bake Cook with dry heat, at around 125°C, for 60 min	Reduces fibre retraction Reduces loss of meat liquids Allows homogenous internal cooking	Renders the foodstuffs assimilable. Tenderizes the meats.

Table 1 *Continued*

Order	Stage/ Operation	Control method	Actions	Effects	Consequences for the nutritional and sensorial quality
13	Preparation	Control card, insertion thermometer	Grill/griddle-cook Use equipment with high temperatures (approximately 180°C) for short periods of time Poultry: 65°C for 15 min Fish: 74°C for 10 min Well-done beef: 70°C for 2 min	Causes superficial coagulation of protein Triggers the Maillard reaction	Enhances the flavour. Renders the foodstuffs assimilable. Is used only for the more tender meat cuts.
14	Preparation	Control card, infrared thermometer	Fry Immerse in hot oil, at temperatures above 180°C	Causes: • the presence of polar compounds, resulting in the degradation of triglycerides; • the formation of polymers, dimers, free fatty acids, diglycerides and oxidated fatty acids. • the saturation of oil and formation of MDA, acrolein and LO products	Causes irritation of the gastro-intestinal tract, diarrhoea, reduction in growth and in some cases death of laboratory animals. Constitutes a risk factor for pulmonary illnesses and oropharyngeal and hepatic cancers.
15	Preparation	Control card, infrared thermometer	Fry Immerse in hot oil at very low temperatures	Enables excess absorption of oil by the food	Produces nutritional and sensorial inadequacy.
16	Preparation	GHP	Removal of visible fat	Reduces the saturated fat content	Enhances the nutritional quality and seeks to maintain sensorial quality.
17	Preparation	Avoid fat dripping on the embers	Roast over a fire	Causes fat pyrolysis	Increases the content of carcinogenic polycyclic hydrocarbons.
18	Preparation	Control card, oven thermometer, insertion thermometer	Bake in a combined oven or steam cook	Guarantees greater protein stability	Preserves the nutritional value.
19	Assembly	Define standards	Enable the repetition of the photographic record model of the preparation	Fulfils the standard of preparation identity and quality	Guarantees the desired presentation.

Table 1 *Continued*

Order	Stage/ Operation	Control method	Actions	Effects	Consequences for the nutritional and sensorial quality
20	Waiting for distribution (oven)	Control card, insertion thermometer	Do not prepare a long time in advance Practice first in/first out in the oven Correctly regulate the temperature of the equipment (80–90°C), allowing the adequate food temperature	Reduces undesirable effects of LO Avoids redrying of menu components, which adversely affects appearance	Enhances nutritional and sensorial quality.
21	Distribution	Control card, insertion thermometer	Correctly regulate the temperature of the equipment (80–90°C), allowing the adequate food temperature	Reduces undesirable effects of LO. Avoids redrying of menu components, which consequently adversely affects appearance	Enhances nutritional and sensorial quality.
22	Distribution	GHP	Use leftovers	Causes continuity in the degradation process	Causes further deterioration of the presentation. Reduces the nutritional value.

GHP, good hygiene practices.

suppliers to the distribution of the prepared food.

Nutritional and sensorial hazards associated with the preparation process of the meat-based menu items are indicated in Table 1. The table also indicates procedures or actions that may be implemented to produce the desired effect and exercise a positive influence on the nutritional and sensorial quality of the food.

Conclusions

By applying the proposed NSQE model, this study revealed links between hygiene–sanitary control and nutritional and sensorial control, as observed from using the same mode of analysis for menu components prepared via foodservice. Both are supported in quality criteria that are periodically evaluated, either through inspections or by using measurement instruments and daily records. Both also consider that, primarily, good handling practices are capable of avoiding a series of hazards that place at risk the quality of the menu components considered here under a broader spectrum.

Thus, one of the contributions of this study is that it identifies a real need for nutritionists to direct their work towards nutritional quality management and reinforce their activities as professionals in the health arena. It should be noted that the NSQE system presented here is under the patenting process.

Nutrition professionals in foodservice management play an important role as health educators and promoters, and their performance as such occurs both as food handlers and as restaurant customers. There is the implicit perception that a meal that is being served represents a model to be followed because there is the work of a nutritionist behind it (Veiros 2002). This is a great responsibility, as basic concepts of nutrition may be transmitted through the menu components that are served.

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