Consumers driven innovation process for rapid design and development of new food products

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Abstract: A big challenge in the food industry is to introducing new food products or reformulating existing ones rapidly without comprising the quality of product itself. Once having future trends and innovative food products to marketplaces, very high rates of the failure of introduced products will reduce to minimum percentages and respond quickly to different market segments. New product development process is more complex, time consuming and risky than ever before due to heterogeneous individuals` preferences and short product lifecycle. Consumers' interaction and understanding their requirements are a vital factor to streamline new product innovation process. The customer as co-creator of products is a grand challenge facing the entire consumer products industry. This paper presents consumer driven framework for rapid design and optimisation of new formulated products with desirable quality attributes on demand to meet the current consumer needs and desires. The framework is driven by different groups of consumers to interact directly in the product design process in terms of their consumer likings. Then, these likings are accurately translated into the production process design to project into a novel manufacturing process platform rapidly and concurrently. A target product of the case study is liquid formulations and in particular on food-grade orange flavoured beverages.
Keywords: *New product innovation, Mass customisation, products design and development.*

Introduction

Today food industry is under pressure to design and develop new products. Hence, a continuous production of successful new products is vital factor to sustaining a competitive advantage in the marketplaces (Jaeger, Rossiter, Wismer, & Harker, 2003). New Product Development (NPD) can be fashioned using new technologies or new market opportunities (van Kleef, van Trijp, & Luning, 2005). The key success factors in NPD of food products (e.g. market knowledge, consumer knowledge and retail involvement) have been highlighted to achieve a successful development process in the food industry. In this condition, involving consumers at the early stages of the NPD process is an essential step to obtain consumers' needs and desires and ultimately their satisfaction. However, placing consumer at the heart of the concurrent product and process design of new products (i.e. a close loop process) is an effective procedure. It starts with consumer requirements and completes with consumer satisfaction (Chen, 2011).

To meet or exceed consumer expectations, efficient and effective methods combined with a proper food production processing should be selected and applied to deliver successful new products. The major tackle facing the food manufacturing companies is the great growth in the number of formulation technological possibilities during the past decades (Benner et al., 2003a). Consequently, new food products are often failed to enter the markets due to either not designed to consumer requirements or not formulated efficiently. Importantly, the failure rates of new products are very high within the first two years of introduction into markets. For example, Sorenson (2006) stated the main success factor for global trend of the NPD is the total annual number of the launched products such as a comparison between Western European industry and Asian and North American industry (e.g. Suwannaporn & Speece, 2010; Gresham et al., 2006; Winger & Wall, 2006).

The high percentage of failure in the NPD Process could be controlled by internal and external quality dimensions. These dimensions are mass-individualization, physical product characteristics, environmental variables and newly developed technologies. For instance, experience in the field has shown that consumer consumption pattern is drastically changed toward personalized consumer product in the recent years such as healthy products (i.e. products with low calories or sugar) (e.g. Linnemann, et al., 2006; Costa & Jongen, 2006; Kutin, et al., 2016). In order to sustain a competitive advantage and keep delivering a successful new product, the traditional methods in the NPD process should be ignored sequential approaches. That means consumer driven the successful NPD process is achieved through placing consumers as co-creators in a close loop process to formulate new products or reformulated or optimize the existing ones.

Due to the demanding change and growth as well as more product individuality, the rapid responding to consumers is a crucial issue to enhance the NPD process in the food industry. Such ability can be supported by advanced processing technology coupled with market and information intelligence to provide consumers with tailored, first-time-right product. This enabling is to identify consumer segments with different product preferences and to use low energy requirements of newly advanced production technologies (e.g. a low pressure, flexible and scalable processing method). In this regard, these technologies will produce a variety of consumer personalised products in the efficient and low cost manner as well as quick and flexible mode according to consumers' needs and desires.
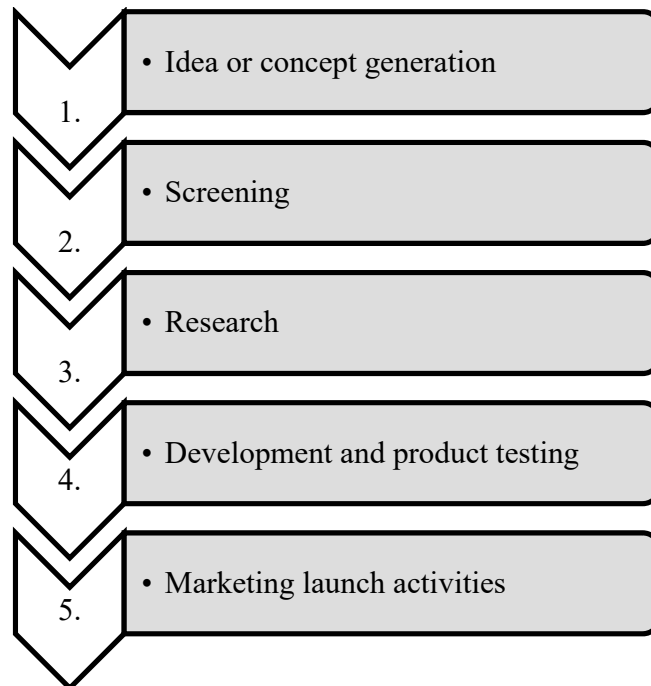
Literature Review

The key challenge in the food manufacturing industry is to design and produce food products which meet consumers' needs more accurately and at a faster pace. Current methodologies for food product development entail the engagement of expert panels and focus groups to direct the formulation of new products, reformulate or optimise existing ones. There are also great uncertainty and risk surrounding the success level of NPD process due to its limited involvement with customers that current market research techniques afford. Customer-driven food product design is a recent trend in the food industry, with increasing consumer demands for more individualised products addressing a variety of needs. Such personalised food design requires strong communication between food manufacturer and consumers regarding the desired sensory properties of the food. Therefore, design and identification of the sensory attributes are essential to developing optimal food and beverage products for individuals. Once such market segments are identified, and then there is the question on how to re-configure manufacturing lines to respond quickly to such emerging markets. In this condition, new efficiencies in food R&D

are required with novel knowledge-driven methodologies that allow the rapid design and optimisation of new food products. Any food design methodology must establish the crucial link between sensorial and physical properties to food product structure and ultimately determine the most profitable manufacturing pathway (Jreissat 2016; Isaev et al., 2016; Isaev et al., 2015; Tsimiklis et al., 2015).

The NPD process has traditionally streamlined in five to eight principal activities as presented in Figure 1.

Figure 1: NPD process based on (Stewart-Knox & Mitchell, 2003)

1. • Idea or concept generation
2. • Screening
3. • Research
4. • Development and product testing
5. • Marketing launch activities

The NPD process has recently become a consumer-oriented approach. Recent researchers have realised the consumer role in the NPD process and in particular in the early stages. Consumer demands should be in a close agreement with launched products to be as a starting point of NPD process and, consequently, success of the process (Zarei et al., 2011; Costa & Jongen, 2006; Stewart-Knox & Mitchell, 2003). Therefore, introducing new products requires reducing the time to markets without compromising the product quality concurrently to improve the efficiency of the product development process (Linnemann et al., 2006; Benner et al., 2003a).

The failure in the product development process could occur due to not reaching the precise target values for requirements of the product. Failure rates in introducing a new food product into the marketplace can reach high percentage; up to roughly 70 to 80 percent (Gresham et al., 2006; Winger & Wall, 2006). Additionally, the product development process in the food industry is greatly based on the innovation method. The innovative food product is more targeted experience than the innovative food processing in the food industry because the food processes may be too expensive and not applicable for normal food manufacturing at the same time. Furthermore, such failures come from three reasons: Firstly, the composition of food products is complex and varied as it plays a significant role in the taste, texture and mouthfeel of the final product. Secondly, food product depends

on interactions between ingredients such as chemical reactions and specifically foods need to be a metastable state in the consumption process to provide the required flavour and taste. Thirdly, production processes could influence the product properties and physiologically active food ingredients resulting in changing in the final quality of some food products such as bread products where they necessitate complex steps to produce in their final required quality (Norton et al., 2006; Benner et al., 2003b).

Food processing companies need to develop continuously new products because of critically rapid adaption to the customer. Subsequently, the key success factors in NPD of food products (e.g. market knowledge, consumer knowledge and retail involvement) have been highlighted to achieve a successful development process in the food industry (Suwannaporn & Speece, 2010; Stewart-Knox & Mitchell, 2003). Moreover, the effective organisation of NPD process requires crucial issues to introduce new products and to obtain a competitive advantage locally and globally in the food industry. These issues are technology, market, the strategic role of new products, cultural management contexts, success factors and success rate of a new product and its methodologies (Suwannaporn & Speece, 2010; Costa & Jongen, 2006).

Research Methodology

Sample Size and Measured Instruments

Untrained consumer panels of 45 members were selected to determine the most preferred sensorial attributes of the target product as input for the innovation process. Those consumers had different backgrounds such as gender, age and nationality to provide products with the various quality attributes. Five sensory attributes of three commercial orange juices were examined: appearance (i.e. colour), flavour (i.e. smell), texture (i.e. smoothness), taste (i.e. acidity) and overall acceptability. These words were used to describe the orange juices due to familiarity to consumers. Interval based questionnaires were used for the evaluation of three different commercial orange juices from the local markets. Respondents were asked to sketch an ellipse shape with regard to their perceptions for the related product attributes on the scale range between 0 and 10(i.e. a 10 point Likert scale).

Data Analysis

Statistical analysis was used to link sensory attributes and physical properties of the intended food product. Also, the experimental design space for the food process technology was established based on our previous research (e.g. Jreissat, 2016; Isaev et al., 2016) to make and optimise the orange beverage formulation and its manufacturing processes. Consequently, Response Surface Methodology (RSM) based on Central composite Design (CCD) was used to demonstrate and test the novel manufacturing system for orange beverages. Independent variables were determined in the experimental design to formulate the orange beverage regarding limits of the formulation parameters, to find main and interaction effects of both formulation and process parameters on the desirable properties. Independent variables were main ingredient concentrations in addition to process conditions. The main ingredients of the orange beverages were Arabic gum (w/w%), xanthan gum (w/w%), orange oil (w/w%).

In order to link the sensory attributes and formulation parameters, these attributes required to quantify using consumer inputs from the online tool (i.e. web application). Then, the measured physical properties that match consumers' likings could be found in the formulation design space by projecting the target product properties. In the other words,

texture resembles viscosity value; appearance represents colour intensity; mean particle size affect smell or flavour level and pH level controls the taste sense. The target properties could be found based on the clustering of physical properties as well as the manufacturer knowledge and experience in order to formulate new product or reformulate (see Figure 2).

Figure 2: Consumer driven framework for rapid food innovation process

A: Ingredients concentrations
B: Process conditions
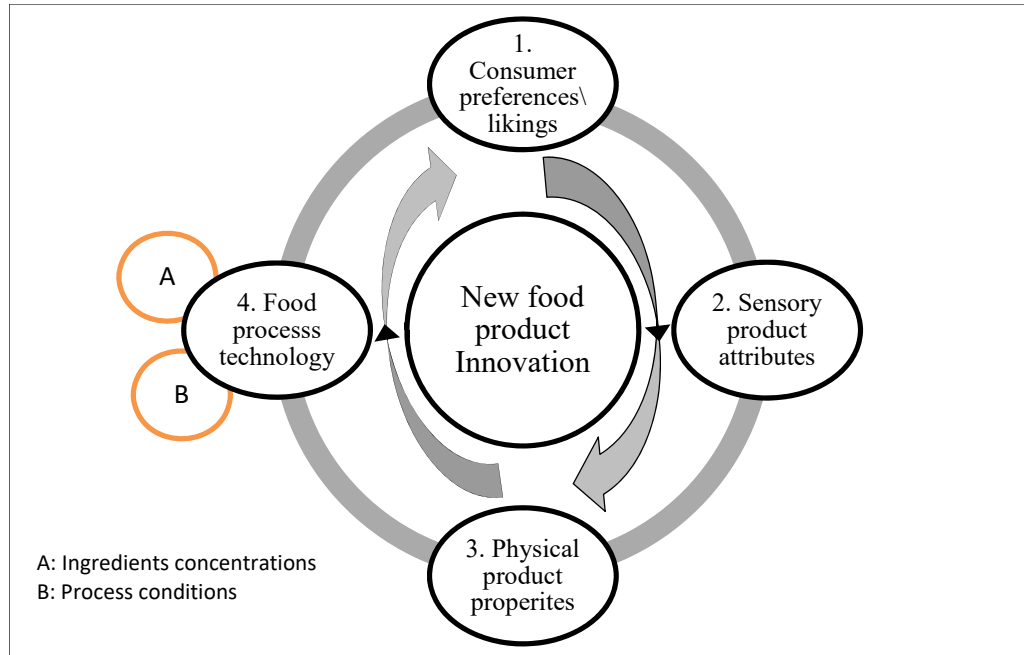
Results and Discussion

45 untrained consumers' profiles (15 members for product A, 15 members for product B and 15 members for product C evaluated three commercial orange juices in order to select the today's product in terms of the sensory descriptors studied (Table 1). The three orange juices were bought from the local marketplaces based on the obtained results from online questionnaire. The online tool was used to determine the most favourite preferences of the orange beverage product in supermarkets. Consumers' acceptability of the new sensorial product qualities and their purchase decisions are considered the main factors affecting the NPD and its innovations in the food and drink industry.

Table 1: Sensory descriptors for consumer preferences

Sensory quality	Sensory descriptor	Quality Range for Juices	Preference liking
Appearance	Colour	Bright-Golden-Dark Orange	Bright Juice
Texture	smoothness	Thin- smooth- Thick	Smooth Juice
Taste	Acidity/sour	Low-High (Sweet-Sour- Bitter)	Sour/ low Acidic Juice
Flavour	Smell	Citrus-Fruity	Citrus Juice

Consumers assessed the product C as bright and sour orange juice due to formulation parameters such as ingredient concentrations and types. In addition, the orange juice C was the best overall acceptability compared to the other products. This is because of the highest

scores of the flavour (smell) and the texture. Consequently, orange juice product c was the target product in terms of these sensory qualities studied according to those consumers or market segments. Indeed, this product is considered as personalised consumer product. Developing such this product in the marketplace has twofold benefits: (a) To reduce the travel need due to establishing a proper manufacturing process that is located closer to its segment markets and (b) To respond rapidly and flexibly to different market segments with

Figure 3: The obtained results for evaluation of the orange juices (A, B and C).
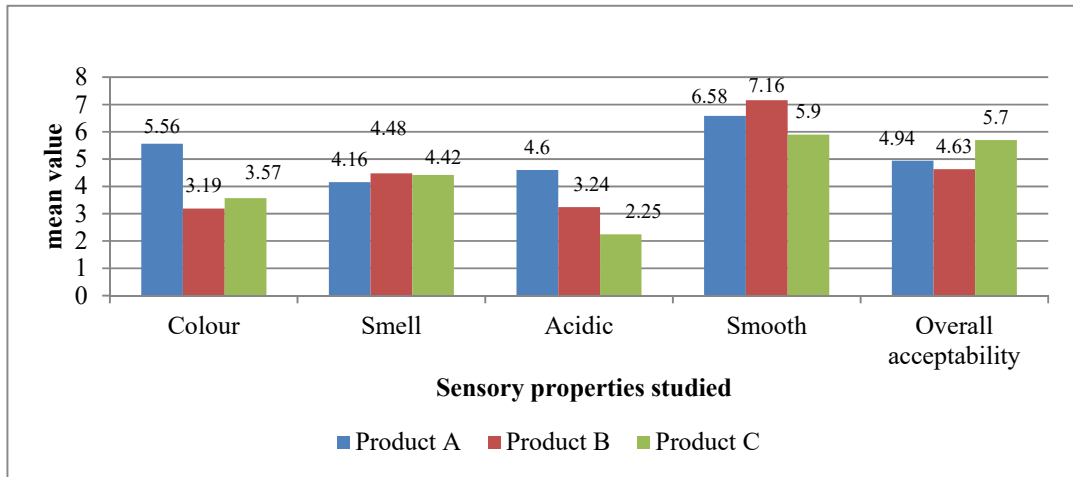
regard to changing in consumers' requirements, demands and needs. The evaluation study for the three orange juice products are shown in Figure 2 in terms of colour intensity, smell, acidity, smoothness and overall acceptability.

Conclusion

In this research, involving consumers as co-creators at early stages of the NPD process to engineer and manufacture products, which meet their needs and demands more accurately and rapidly. R & D traditional methodologies entail producing by products or innovative products ideas without engaging the end consumers in the concept development stage. Consumer acceptance and product design problems as well as high costs are the expected results in the later stages of the product development process. Therefore, it is important to remain flexible quickly responding to the increasingly demanding consumer desires. From this point, this research presents the framework of consumer driven innovation process to bridge NPD process for rapid and flexible design and development of newly formulated products. That in turn implicates the ability to identify the needs and preferences of diversified markets with several geographically different products. As a result, mass personalised consumer products have potential advantages to reduce the travel need and to respond rapidly with demand growth and changes. Future research is still required to explore online web applications or social media to gathering information from market intelligence to enhance consumers' perceptions. Also, the ability to provide devices supporting rapid responds that allow for the best consumer requirements for an individual customer to be rapidly determined will be a key part of the growth.

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