IOT in the development of information support of food products for healthy nutrition

IOP Conf. Series: Materials Science and Engineering **497** (2019) 012112 doi:10.1088/1757-899X/497/1/012112

IOT in the development of information support of food products for healthy nutrition

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Abstract. The marking of food products comprises mandatory information regulated by legislative enactments of the state regarding the contents of nutrients. A restricted information capacity of the package features no opportunity to accommodate more exhaustive information on the advantages of food products for the health of potential consumers. The advantages of food products for the health, such as antioxidant capacity thereof is variable depending on quality and quantity composition of ingredients and technologies as exemplified by blended juices and enriched bakery products. It is impossible to accommodate the results of attaining maximum antioxidant capacity by the new food products and the visual presentation thereof in the margins of standard information panel of the package. A graphical representation of the received information is more relevant for the consumer, but it occupies the volume of information exceeding the margins not only of standard information panel of the package, but QR code too. It has been proposed with the use of QR coding to provide the consumer with a possibility of switching over to the information resource of the manufacturer of commodity group, which may comprise both inherent information and the information of external development agencies, including scientific publications on antioxidant properties of food products. The use of IOT will help provide consumers with more exhaustive information on healthy nutrition and stimulate acquisition of food products useful for health.

1. Introduction

The digital technologies in the contemporary world have become an integral part of our life beginning from Internet technologies of both information space and online communication routes and utilization thereof in different industries of national economy. From the point of view of quality and safety of food products the digital technologies make it possible to effect inspection at all stages of life cycle thereof (electronic genealogic tree, service-oriented architecture, global identification) [1, 2]. The authenticity and freshness of the food product can be identified by means of special sensors with IR-Fourier conversion and comparison of the obtained spectra with the standard. The obtained results can be automatically transmitted not only to manufacturers, but to consumers too by means of special applications of the Internet of things (IOT) [3]. The digital technologies have begun to be used in molecular genetic diagnostics for identification of authenticity and mutations in food products,

presence of allergens in soya beans and peanuts [4, 5]. The polymerase chain reaction (PCR) takes place in one chip and after thermal cycling the data will be read by three-color device for fluorescent scanning. 3D technologies making it possible to build structures that are complex with respect to configuration and formulation, the extrusion-type food products, have not get around the food industry [6].

One can distinguish two fields of IOT application, manufacturer and consumer, in the food chain: raw materials — production of food products — trade — consumer, despite its multifunctional nature and a great number of participants. IOT is mostly associated for a consumer with non-food goods (household appliances, gargets, smart home) and with functions they represent. IOT is mostly of reference character for a consumer regarding food products making it possible to give information about composition, benefit for health, calculate daily human diet with respect to main macronutrients (proteins, fats, carbohydrates, calories) or individualized diets [7, 8]. At that, a consumer becomes more active, e.g., placing its own information across social media platforms on the benefit of selected diets, quality and safety of food products. The food-related blogs became a popular platform for the development of individual recipes of dishes, discussing menu cards of restaurants, putting forward own opinions in the open forums [7]. IOT is used for awareness education on food competence, especially among teenagers, who are the main users of applications [9].

A keen interest to healthy food products has been confirmed in experiments with students, who have selected yoghurts within limited period of time and without limitations on the basis of visual information. In this case the product marking with traffic light labels became a factor stimulating such choice [10]. A greater volume of information on the benefit of food products for health stimulated purchasing healthy food products in automatic teller machines [11]. A necessity of expanding information on the benefit of food products for health has been demonstrated with the participation of dieticians when substantiating a choice of packed food products, who to a greater degree relied on their experience and knowledge, that on information in the marking [12].

A growing interest of consumers to interrelation between food products in human diet and health has increased a demand for information on the benefit of food products for health. Though, information on the benefit of food products for health is minimal in the marking due to insufficient informational capacity of the package and can be only confined to the data on the content of proteins, fats, carbohydrates, calories.

2. Analysis of information provided in marking on the benefit of food products for health and methods of its acquisition

The mandatory requirements to information on the benefit of food products for health are regulated in Russia by the requirements of Technical Regulations of the Customs Union TRTS 022/2011 ‘Food products in terms of marking’. They are confined to indication of content of the main macronutrients: proteins, fats, carbohydrates, calories. The recommended distinctive features are also minimal — ‘protein / dietary fibers source’ or ‘high content of protein / dietary fibers’ ‘sugarless’ and other brief information.

The requirements to mandatory information in the countries of the European Union feature the amount of saturated fat, sugar and salt. Besides, a list of nutrient composition is presented in strongly defined sequence only: fats, saturated fats, carbohydrates, sugars, protein and salt. The information can be expanded up to 12 nutrients, which are provided on a voluntary basis depending on the type of food products. The most expanded mandatory information of the benefit for health in the marking is envisaged in the USA, which take into consideration not only the progress of sciences about nutrition, but also the results of population screening study. An essential percentage point of people with obeseness and cardiovascular diseases has brought about a revision of requirements of mandatory information on the content of nutrients of the food product at the package. Since 2018 the requirements have been appended with information on added sugar, vitamin D and potassium, iron and calcium. The elimination of deficiency of vitamins A and C amongst people has resulted in the exclusion of mandatory marking of quantity thereof in the food product.

The analysis of general requirements to receiving information on the benefit of food products for health has made it possible to form a structure of methods of receiving it (figure 1).

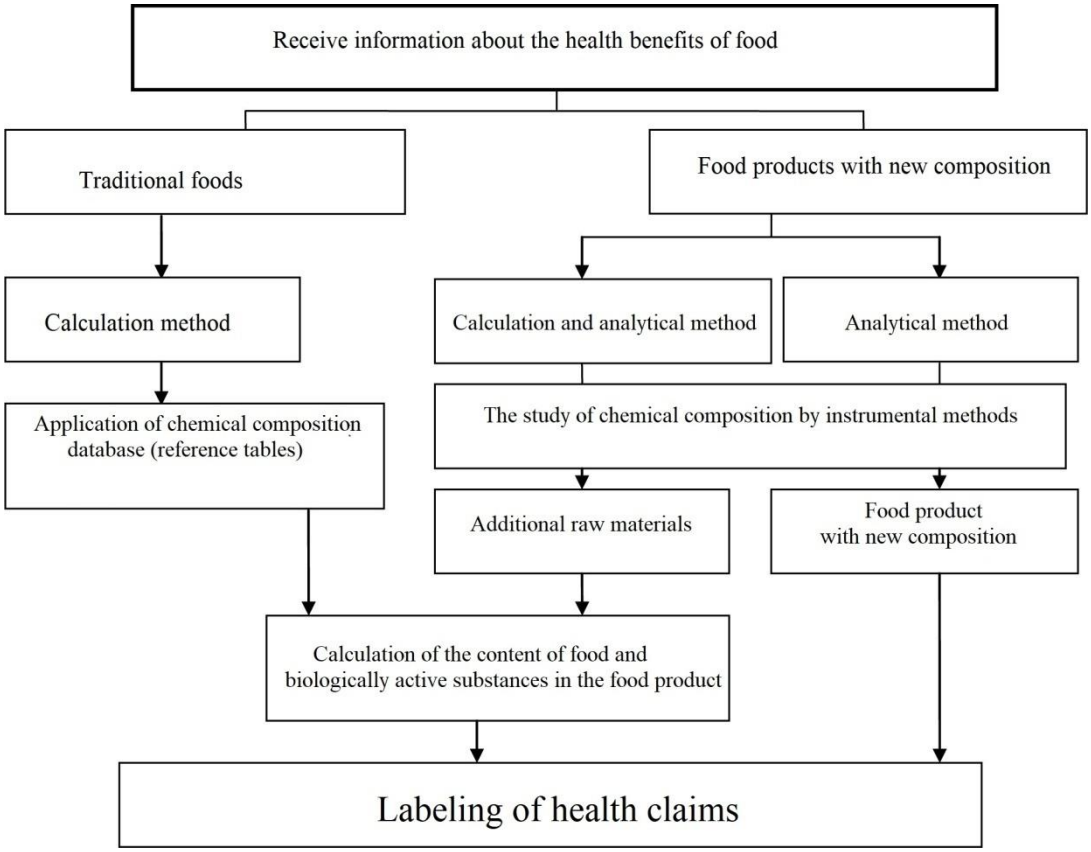


Figure 1. Methods of receiving mandatory information on the benefit of food products for health.

The reference data on chemical composition of the food product or ingredients used in its formulation can be referred to as the sources of providing information on the benefit for health. As a result, the manufacturer can determine the content of the main nutrients by means of a calculation and use this information in the marking. In case of developing a food product of a new composition with the use of a new ingredient, it is possible to make use of the calculation and analytical method. The analytical methods are used to determine a quantity of nutrients in the new ingredient, while the rest information is provided with the use of reference data. The use of analytical method only is required in the event of receiving information about new properties of the food product determining its benefit for health. What properties does the antioxidant capacity (AC) of food products represent? This information demands evidential basis of investigating contents of individual antioxidants and AC of food product in vitro and in vivo [13, 14]. The emergence of new investigations expands the evidential basis, as a result of which the information on the benefit of antioxidants for health becomes dynamic.

The specialized websites can provide more details about the benefit of food products for health. However, low qualification of Internet users complicates acquisition of the required information during transaction of payment for a purchased item. In order to accelerate the sales turnover at the retail facility, it is necessary to provide a buyer with an opportunity of instant acquisition of information required thereby, for which purpose it is possible to use QR code [15]. Owing to a capability of quick reading and a capacity up to 2953 bytes, a system of QR codes makes it possible to place additional statistical information about a subject of sale, including information about its benefit for health, and follow, if a user intends so, a link to the manufacturer's website provided with

additional, including dynamic information. The structure of information exchange between a consumer and a manufacture of a subject of sale is provided in figure 2.

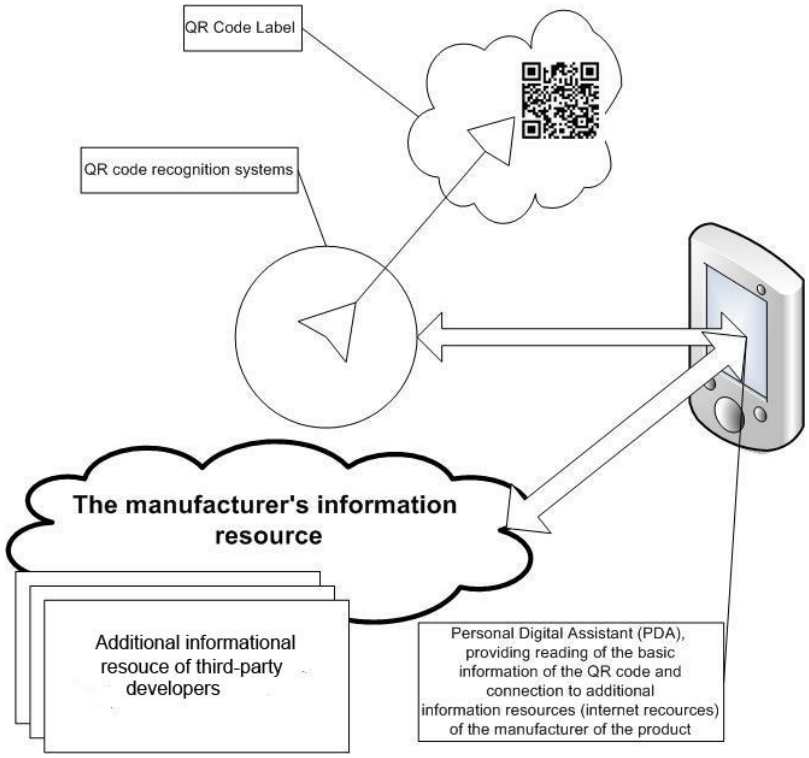


Figure 2. Structure of information exchange.

The manufacturer's website can provide a consumer with complete information about a subject of sale, utilized raw materials and technologies, full range of similar goods as well as provide information about AC made according to the manufacturer's request or specify additional information assets of the external development agencies, e.g., a list of scientific publications.

3. Analysis of information volume for consumer on the benefit for health as exemplified by antioxidant capacity of food products

In order to assess the volume of information necessary for a consumer, a task of informing a consumer on AC of food products has been selected, which is the dynamic information, which changes depending on the used raw materials, recipe composition, technologies as well as methods of investigations, model systems in vitro and in vivo in medical-and-biological and clinical studies. The information is appended by individual antioxidants, used raw materials and finished food product.

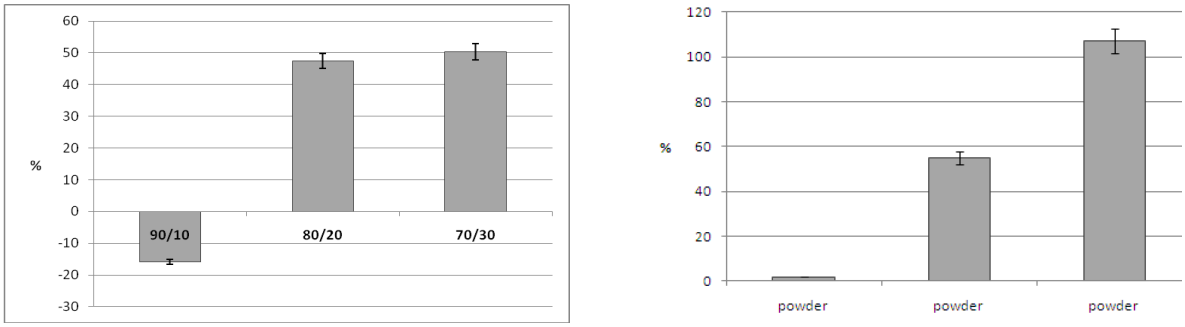
3.1. Materials and methods of investigations

In order to confirm dynamics of information on AC of food products, two groups of food products have been selected depending on expectations of consumers. The first group of food products includes blended juices with undoubted antioxidant properties; the second group includes bakery products, which are not associated with AC by consumers. Juices have been blended by mixing apple juice and sea buckthorn juice in proportions of 90:10; 80:20; 70:30 with consideration of organoleptic properties. The apple juice has been used for reference. The bakery products have been produced of wheat flour (reference) and flour substitution for powder of sea buckthorn squeezing in the amount of 1, 3 and 5%. Further increase of the quantity of sea buckthorn processing products is unreasonable due to aggravation of organoleptic properties of bakery products [16].

AC of food products being investigated have been determined with the use of FRAP method with o-phenanthrolin [17]. The obtained results have been recalculated for ascorbic acid in 1 ml for juice and for 1 g of dry substance for bakery products. In order to calculate AC theoretical values of new products, they have considered the values thereof in the source components taking into account its content in formulation.

3.2. Results and discussion

The use of sea buckthorn juice during blending and sea buckthorn powder in the recipes of bakery products used to bring about an increase of AC of new food products as compared with reference samples. So, AC of apple juice amounted to 2.25 mg/ml, while after blending it with sea buckthorn juice AC has increased 1.06, 2.24 and 2.68 times, accordingly, after adding 10, 20 and 30% of sea buckthorn juice. When comparing actual values of antioxidant activity with theoretically calculated ones, it has been established that synergetic effect appears only in case of blending apple juice and sea buckthorn juice in the amount of 80:20% and higher (figure 3).



(a) (b)

Figure 3. Deviations of actual antioxidant capacity from theoretically calculated ones in food products with the use of products of sea buckthorn processing, %: (a) — blended juices from apple and sea buckthorn, (b) — bakery products, enriched with sea buckthorn powder.

The use of sea buckthorn juice in smaller concentration, vice-versa, reduces AC of blended juice by 15.85% against theoretically possible one. The obtained results are proven by the studies of other authors [18].

The enrichment of bakery products with sea buckthorn powder has resulted in the increase of AC thereof irrespective of powder quantity. The limitation of its quantity in formulation of bakery products has been determined by organoleptic indicators which proves data of other studies [19, 20]. In this case, the composition of antioxidants changes depending on the temperature and duration of baking.

In order to improve perception by a consumer, the most suitable way to display the received experimental and analytical material on AC of the food products is a graphical one (diagrams, graphs, figures, photos), however, these forms of information presentation feature substantial volume and can not be saved in QR code. The use of QR coding (when entering data into code to move to the manufacturer's website) can provide a chance to a buyer to quickly access information on the commodity group of food products, which capacity can accommodate all information necessary for a consumer.

4. Conclusion

The mandatory information for a consumer in marking on the benefit of food products for health is specified (in this or the other volume) by legislative enactments of different states. This information is insufficient for reflecting all useful properties of food product, while additional promotional content is

not always authentic. The use of QR code in the marking of food products (for electronic reading) helps increase the information volume and present it graphically, which method is the most suitable for perception by a consumer. The information capacity of QR code is insufficient for displaying all information necessary for a consumer as exemplified by the studies of antioxidant capacity of blended juices and enriched bakery products. In order to solve an informational problem, it is necessary to introduce data into QR-coding for moving to the website of food products manufacturer, where more comprehensive and different information for a consumer can be placed. The information may include graphical information both of the manufacturer and external development agencies.

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