REVIEW

REVIEW OF SCIENTIFIC RESEARCH RESULTS IN IDENTIFICATION OF PLANT RAW MATERIALS IN FOOD PRODUCTS

Yu. V. Golubtsova

Kemerovo Institute of Food Science and Technology (University),
Stroiteley blvd. 47, Kemerovo, 650056 Russian Federation

* e-mail: ula.gol@mail.ru

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Abstract: Currently, the science-based capabilities have been generated to develop and test various identification methods of food products and reveal adulteration using advanced technique and processes. This article reviews researches and developments to identify the plant raw materials in food products based on morphological, anatomic, physical and chemical test methods and the latest DNA-technologies. Review of physical, chemical, anatomic and morphological test methods to identify raw materials both as discrete and as the food content validated that these methods are useful to differ the herbal material with apparent specific peculiarities in structure and chemical content, though, in most cases, they are not adequate enough to differentiate the used raw material by species and genus. In the sphere where DNA-technologies are applied to identify the plant raw material, various methods for DNA extraction, requirements to DNA-targets, methods to optimize the polymerase chain reaction (PCR) stages have been developed; a range of developed methods are in place for species identification of plant-based additives in food products by species which is rather relevant in view of promotion in the market of cheaper substitutions for food ingredient components. The review of national and international scientific publications and intellectual property items to work with PCR-based species identification of the fruit raw material showed that this method differs in high specificity and is practically the only method of species identification available.

Keywords: food products, plant raw material, identification, DNA-technologies, PCR analysis

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INTRODUCTION

Currently, the food industry concentrates, to a greater extent, on the production of mixed food products enriched with herbal supplements that contain bioactive substances as elements wholesome for the human health. Food processing plants may often replace the content of fruit and berry supplements in various food products by the dye staff and flavoring that are cheaper for reasons of cost efficiency. Problems with identification of falsified plant raw material in food require the relevant identification methods to solve them. These methods are of high priority in the list of measures to be taken for safety and quality of food products to be sold.

The Federal Law on Technical Regulation specifies the development of new requirements to each type of food product, including vegetable derivative that should be developed as technical regulations with the main requirement to ensure chemical and biological safety to protect human health and life and to prevent actions that confuse consumers.

In connection with the above, the important task is to develop objective species identification methods of plant ingredients that make up finished products.

The purpose of this article was to review scientific developments in the sphere of herbal material identification in food products using morphological, anatomic, physical and chemical test methods and the latest DNA technologies.

OBJECTS AND METHODS OF STUDY

The work is performed at the Kemerovo Institute of Food Science and Technology (University). The study object included: scientific and methodic publications, articles in scientific periodicals, conference materials, intellectual property items, regulatory documents, Internet resources. To analyze the theoretical data, the methods used included registration, filing, grouping, classification, comparative analysis and consolidation of scientific materials.

REVIEW

The review and analysis of scientific literature indicated that researches and developments are available to identify the plant raw materials in food products, pharmaceuticals, and methods are offered of herbal material identification based on morphological,

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anatomic, physical and chemical test methods and using the latest DNA technologies.

The works performed by Pchelkina V.A. [1, 2], Pchelkina V.A. and Burlakova S.S. [3] on the development of micro-structural methods of plant component identification in the meat raw stock and finished products studied morphological peculiarities of plant elements of proteic and carbohydrate origin used in the production of meat products, their modification when processed. Microstructural parameters (shape, particle size, tinctorial characteristics) and their evaluation criteria are defined for identification purposes. It was found out that the methods developed make it possible to quickly and objectively evaluate the structure of both raw meat and end products. As compared with physical, chemical and PCR methods applied, the developed methods will help to cost-effectively determine the herbal components and analyze the raw meat and finished products.

Popov A.I. et al [4] developed and proposed the morphologic and anatomic analysis of subterranean organs of spice plant rhizomes, namely ginger and turmeric that may be used to characterize the herbal material in detail in the solid, fragmented and powdered form and used to make supplementary documentation to standard documentation articles on raw material identification.

The identification method of raw stock and products of animal and plant origin based on BOB-electrophoresis is developed. By using the SDS ionic detergent electrophoresis (8B8), the method developed to analyze meat products enables species identification of the protein, quantification of the multicomponent minced meat components, including protein supplements of plant origin. Characteristic species-specific marker protein areas are determined for species identification of the protein as the component of food product. A collection of electrophoretograms is compiled for proteins of animal and plant origin [5, 6].

The technical approach is known to perform the screening gas chromatography and mass spectrometric studies of the qualitative composition of the medicinal herbal substances in BAA (Biologically Active Additives). The qualitative composition of 50 pharmacopoeial species of herbal substances is studied by the method of gas chromatography and mass spectrometry. Biochemical markers are proposed for 15 species of herbal substances that make it possible to identify them as part of multi-component herbal collections and BAA. The method of qualitative chromatographic amd mass spectrometric analysis is developed to determine the marker substance 4-vinylquaicola in garden sage leaves [7, 8, 9].

Certain works relate to the study of local herbal substance use as the source of bioactive substances for syrup and beverage production. The plant raw materials were screened as the source of bioactive substances of antioxidant nature to create basic syrup recipes; the proportion of ingredients in syrups in view of taste thresholds of sensitivity and redox dynamics (EhRed/ox) of extracts is justified; extraction parameters of vegetable raw materials by mathematical modeling are optimized; syrups recipes and techniques are worked out using Laminal and Modifilan; the trade analysis is performed for extracts and syrups made of vegetable raw materials, nutrition value, bioavailability and antioxidant activity during production and storage are indicated, methods of raw material analysis are selected [10, 11, 12].

Eller K.I. and Balusova A.S. [13] analyzed flavanoid components in herbal estracts and herbal products by the combination of HPLC and solid phase purification; authenticity of herbal extracts is established as the raw stock for BAA [14]. Indicative polyphenol compounds of the propolis are identified and measured [15].

Research and methodology concepts are developed to evaluate the quality of plant raw material and its derived products that allow revealing most evaluate (significant) criteria to detect the wheat grain falsification. Comprehensive researches are performed and the criteria selection is scientifically validated to determine the type composition of hard and soft wheat to identify, by quality and quantity, the soft wheat impurities in hard wheat sorts [16].

The major task of food product identification is the elemental analysis study against trace amounts in the plant raw materials and plant-based products. I.V. Podkolozin [17] worked out the method to define rare earth elements and uranium in the natural mineral water, tea and coffee by ICPMS - Inductively coupled plasma mass spectrometry – combined with the dispersive liquid-liquid micro-extraction; its analytical and metrlogic parameters were assessed, either. A database is created to identify food products by the content of certain elements, including rare earths elements and uranium. The study results are used by the chemical analysis laboratory of the Federal Animal Health Care Center to identify the food products.

The All-Russian Scientific Research Institute of Food Biotechnology of the Russian Academy of Agricultural Sciences developed absorption and luminescence methods for identification and evaluation of safety and quality of the rectified ethyl alcohol by the spectral analysis of organic impurity trace amounts contained in the tested item. Savelyeva V.B. [18] obtained experimental data to indicate that the rectified ethyl alcohol from various raw materials are characterized by availability of the group of luminescent and non-luminescent traces available in each of them that result in the excitation spectrum – emission – absorption individual for the given sample.

In recent years, new spectroscopy methods are used to study the quality of food and medicinal herbal stock. The Fourier transform infrared spectroscopy (FTIR) of the attenuation total reflection (ATR) is getting more popular in the study of the raw stock quality and authenticity. When using this method, the infrared light penetrates the sample to about one micrometer in depth, and the detector defines the absorption spectrum. This method has some advantages to the technique of transmission measurement. Any samples of any form and state of aggregation – solid and liquid, powders, pastes, granules, suspensions, fibers, etc. – may be studied. The entire analysis takes a minute only

including the sample arrangement, data collection and processing [19, 20, 21].

Values of characteristic IR spectrum frequencies are identified corresponding to the sample chemical composition and the authenticity of the food or herbal substances is defined as per tabulated spectral data for reference raw samples. In practice, while interpreting the spectrum, the position of absorption bands and their intensity (high, medium and weak) are determined. The IR spectrum is compared starting with the analysis of characteristic bands that are usually well seen in the spectrum, whereas the low frequency region is compared when they match each other. The match of the spectral curve of the test substance with the standard spectrum pattern indicates the identity of two substances (raw material types). The absence of bands in the spectrum of the test substance observed in the spectrum of the reference sample clearly indicates that these substances differ. The presence of the greater number of bands in the test sample spectrum as compared with the reference spectrum can be explained as the test sample contamination and dissimilarity of both substances. Thus, the test sample IR spectrum should have absorption bands fully matched with those of the reference spectrum in position and relative intensity.

E.N. Grin'ko [22] was the first to obain and descrie IR and Raman spectra for 11 kinds of herbal substances and 8 reference samples.

The infrared spectroscopy method is widely used to assess authentication and quality of herbal substances, in particular to assess the industry-related substance contamination [23–27] in studies to identify the components of herbal substances and food products of plant origin [28, 29].

The Kazan State University validated the use of electrochemical methods to evaluate the integral antioxidant capacity of medicinal herbs and food products [30]. A new approach is elaborated to evaluate the integral antioxidant capacity using electrogenerated standard solutions (bromine compounds). Stoichiometric respond factors are specified for 12 separate bioactive compounds with antioxidant properties with electrogenerated halogens and some oxidants – metal ions. A study was performed of the antioxidant activity of 46 food extracts and 42 herbal agents based on medicinal herbal substances.

Sechenov I.M. First Moscow State Medical University elaborated unique methods to identify and measure hydroxicinnamic acids in medicinal herbal substances and alimentary food stock, BAAs and food products. Most efficient chromatographic conditions are arranged to determine chlorogenic, neochlorogenic, cryptochlorogenic, caftaric, caffeic, p-coumaric, ferulic, cichoric, dicaffeoylquinic, dicaffeic, feruloylquinic acids. The assay methods of hydroxycinnamic acids in medicinal herbal substances and alimentary plant stock, food products is elaborated. The raw stock that can be the source of hydroxycinnamic acids and where hydroxycinnamic acids may act as indicator components. The raw stock is identified containing a small amount of hydroxycinnamic acids and the raw stock is extracted that does not contain hydroxycinnamic acids [31–36].

The patent search was performed in the field of physical and chemical methods developed to detect adulteration and identification of plant-based products.

The patent 2208785 [37] of the Russian Federation is in place on “Cognac identification Method” that involves the creation of sensor matrix to detect major components of the test product flavor by modification with sorbents of resonator electrodes, introduction of reference and test samples in the cell detection, registration of analytical persorption signals of the flavor main components. Dinonyl phthalate, polystyrene, polyethylene adipate, Triton X-100, bee glue, crown ether, beeswax, polyethylene glycol of PEG-2000 grade are used as sorbents. Electrodes are modified with sorbents of 10–20 mg in mass, and samples are put in detection cells at 0.01 dm^3. Analytical signals are recorded sequentially in line with individual kinetic interaction parameters of main components of cognac flavor. The spider diagram is plotted as per signals and identified by visual comparison.

Patent RF no. 2006120721 [38] offers the method for express determination of integral falsification of dry and liquid food products as per the total score of their capillary adhesion properties that ensure active extraction of discrete elements of the restored aqueous composition exposed to the complex mechanical and gravimetric power and at total application of capillary adhesion forces, pressure fixation that retains the capillary volume of the discrete extracted element of the tested aquatic food composition, followed by gravimetric determination of dynamic characteristic parameters of discrete elements.

The object identification method is available to create its characteristic electrophoretic profile [39]. The object identification is based on comparison of characteristic profiles that correspond to the certain object with "limits". The invention ensures rapidity, simplicity and informativeness, as well as improvement of efficiency and selectivity in separation of characteristic components of the object and decrease in the detection limit that allows obtaining the proper electrophoretic profiles.

Patent RF no. 2377556 [40] describes a method to determine distinct features in the chemical composition of monogenic sunflower lines. The invention relates to the sphere of the method development on identification of the natural material composition by liquid separation resulting from sample preparation by the gas chromatography. The method includes treatment of sunflower petal extract with the adsorbent followed by determination of characteristic chemical compounds by mass spectrometry contained in extracts. Extracts were prepared by extracting the plant material with the composition of the chloroform and methanol mixture. The chloroform and methanol mixture was taken in the ratio of 7/3 by volume. The technical result is in simplicity of sample preparation and high performance. Also, this technique can be used as the method to define the variety of sunflower during seasonal researches.

The patent [41] is developed at the "Lianozovo Dairy Plant" OJSC to determine the content of tartaric acid and its salts to detect falsification of juices and lactic stock and diary products. The development ensures to detect and measure the concentration in the solution of any substances containing tartaric acid anion, i.e. as the tartaric acid itself and any of its salts (tartrates). The method may be also used to detect falsification of juice and juice drinks with tartaric acid additives or its salts. Furthermore, the development can be used in the chemical industry to analyze the industrial waste and commercial samples of tartaric acid and/or its salts – tartrates.

The patent [42] is also available that describes the method to determine the citric acid and its salts in food products to control the product quality and falsification. This method involves the sampling procedure and its oxidative bromination. Thereafter, the sample is added with an excess of reducing agent. The value of at least one optical sample characteristic is measured which is used to validate availability of citric acid and its salts. The content of citric acid and its salts is determined by multiplying the measured value of the sample optical characteristic to the calibration factor of the device. The development increases the method versatility and its accuracy.

Nizharadze Eteri Shotaevna [43] developed a method to control the tangerine juice naturality, both natural and sugared. The mass concentration values are defined in the test sample of total and amino nitrogen (official number), proline, ash mass fraction, its alkalinity, and chloramine number. If at least one of the indicators above is not within the limits of variation, the act of naturality violation is reported.

Kharkiv State University of Food Technology and Trade developed the "Method to determine the beverage concentration" [44]. The method aims to improve the concentration measurement accuracy of drinks, preferably fruit and berry juices, including in case of falsification with dilution. The method includes the selection of the test and control juice samples, measurement of the sample optical density in the visible spectrum, and concentration measurement as per the control sample calibration curve, wherein prior to measure the optical density, aqueous extracts are prepared of test and control samples and the solution of diazotized para-aminobenzoic acid is added.

The State Scientific Institution "Research Institute of Children's Food of the Russian Academy of Agricultural Sciences" developed the method of express identification of integral falsification of dry, plastic or viscoelastic food products based on their total values of capillary and adhesion properties. The process involves an active extraction of discrete elements of the restored aqueous composition exposed to complex mechanic and gravimetric force and total application of capillary and adhesive forces, pressure recording that retains the capillary volume of discrete extracted element of the test aquatic food composition, followed by gravimetric determination of dynamic characteristic parameters of discrete elements [45].

A method is described for quicker detection of peanut or shrimp allergens. For this purpose, CHI400C-type sensor of electrochemical workstation and three-electrode system is designed with the platinum electrode as the reserve electrode, the electrode Ag/AgCl is used as the reference electrode, and metallic electrode is modified to the modified electrode enveloping the antibody and is used as the service electrode. When the sample antigen or antibody in combination with the antigen or antibody is transferred to the working electrode of the plate, the plate oscillating frequency respectively decreases due to the ncreased load. Allergen detector addresses shortcomings of the existing detection methods such as ELISA and PCR which run with complex operations, usually require the standard enzyme reagent and are reported to have long time operations [46].

The patent [47] offers the method to detect the falsification of concentrated fruit juice for the sugar syrup added. The method is based on the use of fruit juice concentrates and sugar syrup mass spectrometry. The components are compared y chromatograms and validate on presence of the sugar syrup in the juice.

The analysis of physical, chemical, anatomical and morphological methods of analysis used to identify the herbal substances, both individually and in complex food systems indicates that these methods distinguish between herbal substances with distinct specific features of the structure and chemical composition, but in most cases they cannot identify specificity and variety of the raw stock used.

Continuous improvement of molecular biology methods and data accumulation on the genom of fruit and berry plants resulted in elaboration of techniques to identify plant raw materials in food products based on DNA technologies using the polymerase chain reaction (PCR). The PCR method allows obtaining the required number of DNA from single cells contained in the test sample for their identification [48]. Specificity of herbal substances detected by PCR distinguishes with versatility, the deeper level of species differentiation, high reproducibility and possibility of quantitative analysis. Furthermore, the DNA is more stable in process conditions as compared with conventionally used low molecular markers [49]. Despite the fact that PCR used for species identification of tissues of plant origin is highly appreciated by foreign experts, this trend has not yet found wide practical application in our country.

Quite many works are specialized in the study of DNA extraction methods from vegetable objects. Researchers [50] have developed the DNA extraction method without the plant material homogenization and centrifugation. The main way to get rid of the cell wall was the correctly selected enzymatic mixture of different carbohydrases isolated from *Trichoderma longibrachiatum*, that hydrolyze the cell walls. Incubation time optimization for each of tested species of plants contributed to DNA exit without its fragmentation.

Methods are used to extract DNA with the solution of fine silicon oxide "silica" when extracted from the agarose gels [51, 52], microorganisms [53, 54], soil [55, 56], some eukaryotes [57, 58, 59], from green foliage [60]. These techniques showed that DNA

isolated with the use of silicon oxide solution may be used for PCR reactions [56, 61] and other DNA manipulations [59].

There are techniques that allow DNA extraction, as per researchers, suitable for restriction and amplification purposes, from bacteria, fungi and plants without the use of potentially harmful solvents, phenol and chloroform [62, 63].

The common problem in higher plants when the DNA is extracted is contaminants, the fruits and berries are reported with the higher content of polysaccharides [64, 65, 66] and polyphenols [67–70]. Further on, it affects the use of DNA in studies by inhibiting the enzyme activity of the reaction [71]. Also, the DNA of extracted samples becomes unstable for long term storage 72, 73]. Different inhibitors in the solution induce inhibition of DNA polymerase activity [74].

The publications describe results of DNA extraction and polysaccharides removal based on various sources [66, 73–85].

There are two main classical fundamental approaches to purify the target DNA: purification by organic extraction [86] followed by DNA precipitation with alcohols and dissolving it in water and TE buffer and the differential adsorption of DNA on the solid support. Currently, the methods of DNA and RNA extraction are widely used based on nucleic acids binding with sorbing carriers. DNA extraction kits are widely commercialized. Silicate [87–89] and rarely nitrocellulose [90, 91] media are often used as sorbing agents. Gel chromatography is practically out of use to isolate nucleic acids whereas the method is popular to isolate amino acids [92].

However, it should be noted that, although methods on DNA extraction from plant resources are developed, there is no unified optimal procedure for DNA extraction, and in every particular case, depending on the type of raw material and its chemical composition, it is necessary to optimize the DNA isolation procedure [93, 94].

The works are performed at the Kemerovo Institute of Food Science and Technology (University) to select commercial kits that allow obtaining high quality DNA from fruits and berries. A comparative analysis of DNA extraction methods of food stock plants is performed. Based on these data the most efficient way to DNA extraction is suggested [95]. Golubtsova A.Yu. and Shevyakova K.A. [96] studied the method of DNA extraction from gooseberry and gooseberry-based products. It is established that DNA of higher concentration and purity was obtained when using the reagent kit “Sorb-GMO-A”. Ostroumov L.A. et al [97] conducted a comparative analysis of DNA extraction methods from samples of fruits and fruit products. It is figured out that the commercial kit “PROBA-TsTAB” and “Reagents kit for DNA extraction from plant resources and food products” (developed by “NPO DNK-tekhnologia” LLC, Moscow) are the most effective. Moskvitina N.A. et al [98] showed that the commercial reagents kits “PROBA-TsTAB” and “Sorb-GMO-A” are most suitable for DNA extraction from fruit and berry processed products.

The genome nucleotide sequences is analyzed of fruit raw material used for food production [99, 100] and their phylogenies [101–103]; parameters of the polymerase chain reaction are optimized; the possibility to use oligonucleotide primers for species identification of peach and apricot in heat-treated products is shown [104]; PCR-test system is developed to identify fruit and berries in the jam (Fragaria moschata, Pyrus, Malus, Ribes nigrum, Vaccinium myrtillus, Prunus armeniana, Prunus persica) [105].

The scholars of the Russian Academy of Agricultural Sciences elaborated the modified high-performance methods of plant resources identification. A method of DNA extraction is proposed using the ionic CTAB detergent (cetyltrimethylammonium bromide), and using the Silica sorbent (Si02). By using the elaborated methods, the DNA may be obtained free of inhibitory impurities and in the amounts required from a variety of products containing components of animal and plant origin. DNA is suitable for qualitative and quantitative analysis. The techniques may be used for DNA extraction and purification of both multicomponent and single component mixtures. Monitoring researches are performed of the raw stock and food products using the techniques elaborated that showed the capacity to be used for screening and quantitative tests to detect non-declared genetically modified ingredients (GMI) in products of animal and plant origin [106–109].

Panyushkin A.I. [110] improved the method of GMO detection, based on the multiplex PCR followed by DNA-hybridization, in heat-treated and non-heat-treated products and forage. The sensitivity and specificity of the modified technique are identified.

Roshchupkina L.V. [111] proposed advanced methods to identify the product components of plant and animal origin based on the protein analysis by immunodiffusion and based on DNA by nucleic acid hybridization with specific DNA probes, and also by using the modified amplification-based procedure that helps to detect components of animal and plant origin, including components from genetically modified sources. High sensitivity and specificity of methods based on PCR are proved which help to analyze mixed minced meat, semi-finished products and heat-treated meat-vegetable sausages.

Fomina T.A. [112] elaborated the method of species identification of meat and vegetable ingredients based on real time PCR.

Intellectual property items are available in our country and abroad to determine specificity of plant resources both discretely and in DNA technology-based food products.

The patent authors [113] elaborated primers and the technique to detect specific sequences. This development can be used to select primers that may detect the specific genome sequence of kiwi, walnut, apple, and banana. The PCR method is the main method to detect and identify the specific sequence and primers comprising DNA contain 30 nucleotide sequences of kiwi, walnut, apple, banana, or soybean on 3'-terminal processing.

To detect falsification in citrus processed products, the patent [114] proposes to use trnL intron sequences to work out primers – trnL3 and trnF3. The length of DNA trnL3 and trnF3 fragments was about 424 base pair (b.p.). The method is effective to identify the orange and tangerine juices.

The patent [115] describes the fruit origin in the fruit juice and includes the following: nucleic acids amplification available in the tissue or juice by the PCR method, comparison of DNA obtained with DNA isolated from tissue of fruits of known genus, species or variety. These method identifes oranges, apples, lemons, limes, grapefruit, banana, kiwi, passion fruit, papaya, peach, pineapple and plum in juice products.

The patent [116] describes the determination method of forage herbs using ISSR-technologies of molecular markers. UBC815 and UBC835, and nucleotide sequences, respectively, UBC815-CTCTCTCTCTCTCTCTG and UBC835-AGAGAGAGAGAGAGYC, are proposed as primers. The method helps to avoid unreliable traditional morphological identification factors and can quickly and accurately distinguish seven pennisetum forage grasses, and the identification result can be used as the reliable basis to validate the category, class, strain.

The patent [117] describes the method of DNA identification in processed food products and fodders. The invention refers to DNA identification by PCR in food products. The given method is used to detect and determine proteins of plant or animal origin or fish in alimentary formula.

The patent [118] describes the method of identification of the strawberry species by the DNA test.

The patent authors [119] elaborated primers to detect fruit trees affected by ASGV (apple stem grooving capillovirus), ACLSV (apple chlorotic leafspot trichovirus), CTV (citrus tristeza virus) and CTLV (citrus tatter leaf virus).

The patent [120] describes the method to detect specific DNA or RNA fragments by the real time polymerase chain reaction. To obtain PCR or RT-PCR results, the special dye fluorescence amplifier was used. The method may be used to detect food products from genetically modified organisms, to determine the raw stock quality.

The invention [121] is used for quality control and preservation of fruits and vegetables. In the context of the melon, the region of DNA gene is identified via the genome library that is responsible for good long-term viability. This DNA region is amplified by PCR and used as a template.

The patent authors [122] elaborated the DNA molecular markers to identify falsifications in oil and fat.

The patent [123] describes the identification method of the plant resource falsification using by polymerase chain reaction (PCR). The authors proved the method reliability to detect falsified commercial products containing plant substances. This method can identify the falsification of paprika in 1% of tomato powder. This may be applied to identify falsifications with tomatoes and paprika.

The patent [124] descries the method to identify the plant specificity. It identifies the kiwi, walnut, apple, yam, banana or soya in the food product based on DNA test.

The patent authors [125] developed the method to identify the particular plant species by studying the genetic sequences of chloroplasts. The method allows identification of kiwi, walnut, apple, yam, banana or soy in alimentary systems.

The method to test soft wheat varieties for presence of hard wheat impurities and ready-made pasta by studying the DNA sequence by PCR is described in the patent [126].

The patent [127] describes the method to amplify specific nucleic acid fragments by the regular chain reaction. Developed to detect GMOs used for food production.

CONCLUSION

The scientific literature and intellectual property items in our country and abroad were reviewed and analyzed and it was figured out that there are researches and developments to identify the plant raw materials in food products, medicinal products based on morphological, anatomical, physical and chemical test methods and the latest DNA test technology.

The existing identification criteria should be expanded as new technologies for raw stock processing, innovative food production technologies are introduced, and the range of multi-component food products is expanded for accurate identification and falsification detection.

The review of scientific papers and patents in the sphere of application of physical and chemical, anatomical and morphological test methods to identify plant resources showed that these methods distinguish between plant resources with apparent specific peculiarities in structure and chemical composition, but in most cases, they do not identify specific and generic differences of the feedstock as part of the food product.

Recently the principle of specific DNA amplification (PCR) has been actively applied when developing the authentic identification of raw stock and multi-component product origin. This concept is universal since it distinguishes with the deeper level of species differentiation, high reproducibility and the capacity for the quantitative analysis.

In the PCR sphere of applications, various methods have been elaborated for DNA isolation, requirements are described set to target DNA, laboratories are equipped to synthesize gene- and species-specific primers used for PCR assay, different ways to optimize PCR stages are described, there is a range of elaborated techniques to identify plant components in food products. However, the works in this sphere are relatively limited, given the huge assortment of food produced with the variety of herbal supplements, peculiarities of creation thereof, urgent researches in the sphere of species identification of plant resources used, development and improvement of test system identification based on PCR.

Review of domestic and foreign scientific papers and intellectual property items dedicated to species identification of fruit and berry stock proved that the PCR-based identification method is of high specificity and is practically the only method of species identification.

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