Production of sauces based on lipidic carotenoid pumpkin extract

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Abstract. One of the main line of the development of food industry is replacing a part of the recipe of classic sauces; however, this problem cannot be solved without using vegetable stock. In particular, we propose using pumpkin, a native plant of the Volga region. The use of the lipidic carotenoid pumpkin extract allows solving a few problems of the food chemistry; however, this study only deals with partial replacement of the raw stock for production of sauces for this product. The preparation of sauces with addition of the lipidic carotenoid pumpkin extract does not require replacing the equipment and process lines, therefore this line of research may be considered a promising one.

1. Introduction
Recently, providing healthy food has become a top-priority issue. Most salads are prepared with mayonnaise-based sauces as mayonnaise enhances the taste and facilitates digestion. Adding non-traditional components to mayonnaise not only enhances the quality of food but also expands the range of mayonnaises and allows creating a product possessing a functional value.

In this study, we propose adding the pumpkin extract to mayonnaise which allows solving a few outstanding problems of the food industry and the agricultural business industry simultaneously, such as implementation of modern practices in production, processing and storage of agricultural products as well as creating personalized functional food.

Health-giving properties of pumpkin are known from the ancient times; moreover, pumpkin is a native plant. Therefore, using the pumpkin extract to enhance the quality of mayonnaise sauce and its organoleptic properties is a promising field of research.

2. Materials and methods
The object of the research is a traditionally-prepared remoulade mayonnaise sauce and a mayonnaise sauce prepared with additional pumpkin extract containing lipidic carotenoid components.

The lipidic carotenoid pumpkin extract is characterized by a high content of lipids, organic acids, and carotenoids. Moreover, the lipidic carotenoid extract is a good source of a variety of mineral substances.

Table 1 shows characteristics of the objects of the research.
Table 1. Characteristics of research objects

| Name of product       | Control sample | Experimental research №1 | Experimental research №2 | Experimental research №3 |
|-----------------------|----------------|---------------------------|--------------------------|--------------------------|
|                       | gross, (g)     | net, (g)                  | gross, (g)               | net, (g)                 | gross, (g) | net, (g) |
| Vegetable oil         | 750            | 750                       | 750                      | 750                      | 750        | 750      |
| Eggs (yolks)          | 6              | 96                        | 6                        | 96                       | 6          | 96       |
| Table mustard         | 25             | 25                        | 25                       | 25                       | 25         | 25       |
| Granulated sugar      | 20             | 20                        | 20                       | 20                       | 20         | 20       |
| Vinegar 3%            | 150            | 150                       | 150                      | 150                      | 150        | 150      |
| Pumpkin extract       | -              | -                         | 10                       | 10                       | 20         | 20       |
| Product yield         | 1000           | 1000                      | 1000                     | 1000                     | 1000       | 1000     |

Next, we produced a reference and experimental samples and estimated them using the following methods: an organoleptic estimation, nutrition and caloric values of the sauces, change of mass fractions of fats and moisture, variation of the general acidity and pH of the medium (active acidity) during storage of the sauces, carotene stability during storage of the sauces, and rheological properties of the sauces.

3. Technology of preparation of sauces using the pumpkin-based extract

Carotenoids have been part of the daily ration of humans for centuries, so their safety is beyond doubt. In September 2012, the European Food Safety Authority confirmed the safety of use of β-carotene as a food additive and a food colorant [1-3].

Generally, carotenoids are more stable during blanching, sterilization, and freezing than other pigments. They remain stable at any pH levels and are only prone to oxidation. The exposure to air, light, and, especially, the ultraviolet range of the spectrum causes oxygen radicals to emerge; this increases oxidation of carotenoids, destabilization of carotene molecules which results in discoloration [4]. Carotene can be preserved in the presence of a protective atmosphere for an indefinite duration.

β-carotene is also a natural antioxidant that can neutralize free radicals (binding active oxygen), reactive and highly activated molecules, thus exhibiting anticancerogenic properties.

A method of producing the carotene-containing extract from pumpkins was developed in the Kemerovo Technology Institute of Food Industry [5,6]. According to this method, pumpkins are pre-processed by washing, removing non-edible parts and seeds, and then pulping. Next, the raw pumpkin pulp (after removing the juice) is extracted with 80–95% ethanol at a 1:1–1:2 pulp-to-extract ratio; then, the solvent is removed with a rotary film evaporator. The obtained extract concentrate is then stored in a vessel until it completely settles into two phases which are then separated. The result of the process is a lipidic carotenoid extract concentrate. The yield of the lipidic carotenoid phase is 1.5–2% [7].

The pumpkin extract is characterized by a high (80–90%) carotenoid content, provided it is stored without exposure to light and oxygen under temperatures of +2°C to +4°C. To reduce the loss of pigments, the carotenoid extracts must be dispensed into containers of dark glass filled with the product to the maximum. The extract must be stored at temperatures of +2°C to +4°C, without exposing it to light and atmospheric oxygen. Under these conditions, the storage term is one year since production.

The lipidic carotenoid pumpkin extract has low microbiological susceptibility. This is explained by a high content of lipids which provide a hostile environment for growth of microorganisms, as well as the presence of carotenoids which also hamper spoilage.

The content of heavy metals is many times lower than the rated values. The product conforms to sanitary norms and GN 1.1.546-96 that regulate the specific activities of anthropogenic radionuclides as well as content of pesticides.
The carotene-containing pumpkin extract is classified as a non-toxic substance according to the International Classification [4].

The use of natural polysaccharides, including pectin, is one of the most promising fields in foodstuff production. The lipidic carotenoid pumpkin extract also contains this substance [8, 9].

We propose adding 1%, 2%, and 3% (weight) of the pumpkin extract to the traditional classic recipe of the mayonnaise sauce. This may help keeping the required pH level, as the extract possesses antioxidant qualities. Moreover, when added to the recipe, the extract may enhance the consumptive qualities of the product as it colors it and gives it a certain taste. For this reason, we have carried out an organoleptic research of the quality of mayonnaise prepared with the pumpkin extract. The obtained results show the samples of mayonnaise containing 1% and 2% of the pumpkin extract received a high grade of the organoleptic estimation. It should also be noted that the mayonnaise containing 2% of the pumpkin extract is characterized by a denser texture than the reference sample. This proves the fact that raw pumpkin contains plenty of pectin substances that are natural thickeners.

The addition of the pumpkin extract into the traditional mayonnaise recipe reduces the moisture content, which is also explained by the presence of pectin substances in the raw stock. At the same time, the amount of proteins and carbohydrates changes only negligibly; thus the caloric value of the new sauces is just 0.15% higher; however, the nutrition value raises significantly, i.e. the content of potassium, calcium, phosphorus, vitamin PP, and ascorbic acid (vitamin C) is higher than in the reference sample (Table 2).

| Name | Mayonnaise prepared according to traditional technology (control sample) | Recipe for mayonnaise sauce with pumpkin extract (1%) | Recipe for mayonnaise sauce containing pumpkin extract (2%) |
|------|-------------------------------------------------|---------------------------------------------------|----------------------------------------------------------|
| Moisture (%) | 25,64 | 25,48 | 24,29 |
| Proteins (g) | 3,17 | 3,21 | 3,28 |
| Fat (g) | 67,29 | 67,29 | 67,29 |
| Carbohydrates (g) | 2,42 | 2,63 | 2,71 |
| Ash (g) | 1,48 | 1,51 | 1,59 |
| Pectin substances (pectin) (g) | - | 0,04 | 0,09 |
| Power value, kcal/kJ | 627,97 / 2627,42 | 628,96 / 2631,61 | 629,57 / 2634,13 |

**Table 2.** Comparative characteristics of the chemical composition and nutritional value of the developed samples of mayonnaise sauce with pumpkin extract in relation to the control sample

| Name | Micro and macro elements |
|------|--------------------------|
| Na (mg/100g) | 454,43 |
| K (mg/100g) | 48,41 |
| Ca (mg/100g) | 36,05 |
| Mg (mg/100g) | 8,41 |
| P (mg/100g) | 56,95 |
| Fe (mg/100g) | 0,81 |

| Name | Vitamins |
|------|----------|
| Vitamin A (mg / 100g) | 0,03 |
| Carotene (mg / 100g) | 0,04 |
| Vitamin B1 (mg / 100g) | 0,021 |
| Vitamin B2 (mg / 100g) | 0,12 |
| Vitamin PP (mg / 100g) | 0,07 |
| Vitamin C (mg / 100g) | 0,06 |
The content of fats in sauces decreases during storage, and it should be noted that the process of oxidation and decomposition of fats was much slower in the sauce containing 2% of the pumpkin extract. The sauces with pumpkin extract are more resistant to changes of acidity (Table 3).

**Table 3. Change in active acidity (pH) in mayonnaise sauces during storage**

| Shelf life, day | Traditional mayonnaise (control sample) | Mayonnaise sauce recipe with pumpkin extract (1%) | Mayonnaise sauce recipe with pumpkin extract (2%) |
|----------------|----------------------------------------|-----------------------------------------------|-----------------------------------------------|
| At the time of cooking | 4.21 | 4.16 | 4.12 |
| 1               | 4.23 | 4.18 | 4.13 |
| 2               | 4.29 | 4.21 | 4.15 |
| 3               | 4.37 | 4.25 | 4.18 |

Active acidity (pH of the medium) of the reference sample changed after storage by 3.8%; for mayonnaise with 1% pumpkin extract added, it changed by 2.16% and for mayonnaise with 2% of the pumpkin extract by 1.46%.

The results of the research of general and active acidity of sauces allow concluding that carotenoids contained in the pumpkin raw stock are natural antioxidants.

The sauce with 2% of the pumpkin extract added is somewhat more viscous than of the sauce with 1% of the pumpkin extract. This is due to the fact that pectin substances contained in the products enhance the stability of mayonnaises; therefore, the more of them are in a sauce, the higher is the emulsion stability.

The calculations of the net cost of the mayonnaise sauce with added lipidic carotenoid pumpkin extract show that the net cost of 1 kg of the finished product increases only by 0.08 Russian rubles, therefore, it does not significantly increase the pricing policy for this product.

**4. Conclusion**

The experimental part included the research of the quality of a mayonnaise sauce prepared using the traditional process and a sauce with the pumpkin extract.

The obtained results show the samples of mayonnaise containing 1% and 2% of the pumpkin extract received a high grade of the organoleptic estimation. Raising the concentration of the pumpkin extract to 3% leads to a pronounced pumpkin smell and an unpleasant bitterish taste. It should also be noted that the mayonnaise containing 2% of the pumpkin extract is characterized by a denser texture than the reference sample. This proves the fact raw pumpkin contains plenty of pectin substances that are natural thickeners.

The research and the comparative analysis of the chemical composition, nutritional and caloric value of the sauces show that adding the pumpkin extract to the traditional recipe decreases the moisture content (the sauces becomes denser) due to the presence of pectin substances and a higher ash content. The amount of proteins and carbohydrates changes only negligibly, thus the caloric value of the new sauces increases only by 0.15%.

The presence of carotenoids that give the pumpkin its bright orange color not only provides the sauce with a pleasant saturated color but also increases its nutrition value. Therefore we consider processing of food pumpkin and production of new sauces a promising direction.

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