The object of the study is the process of forming the quality characteristics of emulsion sauces-dressings for the HoReCa system, enriched with prebiotic additives. The problem of rationalizing the stability and improving the organoleptic profile of model emulsion systems for sauces-dressings containing valuable hemp oil, prone to oxidation due to the content of ω-3 polyunsaturated fatty acids, is considered. The concentration of prebiotic additives in the model emulsion system of the sauce-dressing is justified (inulin – 3.5%, oligofructose – 4.0%). It was established that the combined use of these additives not only stabilizes the consistency of the product, but also significantly reduces bitterness (by 44%) and increases the creaminess of the texture (by 21%) compared to the control sample. This phenomenon is due to the complex effect of prebiotic additives, which exhibit both stabilizing and antioxidant activity. The mechanism of action consists in modulating the rheological properties of the system by changing the interfacial tension and forming additional water-binding complexes. In parallel, selective binding of free radicals is observed at the interface of the oil and water phases, which inhibits the processes of lipid oxidation. Such structural changes lead to increased stability of the emulsion and improvement of its textural characteristics. A feature of the obtained results is an integrated approach that combines improved sensory qualities with increased stability of the finished product. Economic calculations confirm that the increase in the cost of the sauce-dressing of the proposed composition by 21% is compensated by the possibility of premium pricing and reduced logistics costs for sales. Practical application of the results allows developing health dressings with improved consumer qualities, adapted to the requirements of the modern catering market

Keywords: sauces-dressings, prebiotic additives, inulin, oligofructose, rheological characteristics, sensory profile

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IMPACT OF PREBIOTIC ADDITIVES COMPOSITION ON TECHNOLOGICAL AND SENSORY PROPERTIES OF DRESSINGS IN HORECA SECTOR

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1. Introduction

The modern food market for HoReCa shows a growing demand for health-promoting products, in particular dressings enriched with biologically active components [1], such as prebiotics. These additives contribute to the improvement of the intestinal microbiota and provide additional health benefits, which is in line with healthy eating trends [2]. The

introduction of prebiotics into dressings requires a comprehensive analysis of their impact on technological parameters, such as rheological properties, emulsion stability and shelf life, as well as on sensory characteristics that determine the consumer appeal of the product [3, 4].

However, given the specifics of the HoReCa segment, some dressings can be prepared directly in the kitchen of the establishment ("under the knife") and have a limited, often short-term shelf life. Therefore, the emphasis in studying the stability of such products should be placed not only on the shelf life, but also on maintaining the quality of the product under conditions simulated for real storage cycles and use in the kitchen. Particular attention should be paid to the interaction of prebiotic components with the oil phase, emulsifiers and thickeners, since their introduction can change the structure, consistency and organoleptic profile of the sauce-dressing [5]. Preservation of emulsion stability, texture uniformity and desired taste qualities throughout the entire shelf life is critically important for ensuring product quality in restaurant conditions [1, 6]. Thus, research into the mechanisms of interaction of prebiotic components with the fat phase and stabilization systems, as well as the influence of these processes on the stability, textural and organoleptic properties of emulsions, is relevant in the field of food technology. The results of such research can become the basis for the development of new recipes for functional sauces and dressings, adapted to the requirements of the HoReCa market and the needs of consumers who prefer products with increased nutritional value.

2. Literature review and problem statement

In [7], it was found that replacing 20% of refined oil with guava seed oil (*GSO*) improves antioxidant properties and organoleptic indicators, but the issue of long-term stability of such a product remained unexplored. This aspect was partially considered in [8], where the use of cocoa butter as a stabilizing component was proposed, which ensures quality preservation for 28 days at 4°C. However, the authors did not take into account the effect of various emulsifiers on the stability of the system with cocoa butter, which limited the practical application of their results.

This drawback was partially eliminated in [9], where the stabilization of linseed oil using *n-OSA* starch and sodium caseinate was studied. Although they managed to achieve relative stability for 90 days, the problem of phase separation remained relevant, especially for products without egg yolk. This highlighted the need to find new stabilization systems for vegetarian emulsions, which was a logical continuation of research in the field.

In [10], the problem of the results of research [9] was partially solved, since this work studied in detail the mechanisms of lipid oxidation in emulsion systems based on hemp oil – another representative of valuable vegetable oils. The authors managed to make significant progress in solving the problem of oxidative stability, proposing optimal concentrations of lecithin (0.8–1.0%) and xanthan gum (0.0–0.1%), as well as proving the effectiveness of β-carotene (0.012%) as a natural antioxidant. However, the study was limited to model systems without taking into account the influence of other functional ingredients, such as prebiotics, which left room for further research. This aspect was partially taken into account in [11], where the antioxidant properties of Gac aril (*GA*) – a natural source of lycopene – were studied. The study showed that GA not only enriches the product with bioactive components, but also significantly increases its oxidative stability, demonstrating protection 1.75–7.58 times higher than the control. However, the authors did not consider the synergistic effect between GA and other stabilizers, such as emulsifiers or thickeners, which limited the possibility of their practical application in complex formulations. An important step in solving this problem was the work [12], which investigated the combined use of inulin (as a prebiotic) and flaxseed powder in food products. Although the study was conducted on a gluten-free cookie model, the results obtained are important for the technology of dressings, since the ability of inulin to improve textural characteristics was proven, and a positive effect on antioxidant properties was also revealed.

The work [13] was an important step in solving the problem of oxidative stability of functional dressing sauces, proposing a blend of linseed, corn and sesame oils (1 : 2 : 1) with natural antioxidants. The authors managed to achieve significant progress in increasing the stability of systems with a high content of ω-3 PUFA (induction period of 4.1 h at 80°C), but the study was limited to refrigerated storage conditions (8 ± 1°C), which does not fully correspond to real HoReCa conditions. This drawback was partially eliminated in the study [14], where a complex antioxidant based on tocopherols and essential oils was developed. The results obtained (an increase in the peroxide value of only 1.2–1.9 mmol ½ O_2/kg in 30 days) confirm the effectiveness of this approach. However, the authors did not take into account the influence of an acidic environment (pH 3.5–5.5), typical of many dressings, on the effectiveness of the antioxidant system. This is the problem that the authors solved in [3], studying the stabilization of emulsions in an acidic environment. It was found that the combination of soy lecithin, xanthan gum and E473 (0.3%) allows to achieve acceptable stability at pH 3.5–5.0. However, the study did not take into account the possibility of combining such a stabilization system with prebiotic components, which limits its use in functional products.

An important addition to this series of studies is the work [15], which considers sugar alternatives in food products. Although the study does not directly concern dressings, its results are important for the development of functional formulations, since promising directions for replacing sugar in food products are proposed, and modern nutritional trends are also taken into account. However, key issues remain unresolved, including the effect of prebiotics (inulin, oligofructose) on the stability of complex stabilization systems, as well as optimization of formulations for different types of fat phases and long-term stability under temperature fluctuations.

Thus, the analysis of literature sources revealed the existing gap between modern achievements in the development of functional sauces-dressings and the practical needs of the HoReCa industry. Despite significant progress in the use of alternative fat components, natural antioxidants and stabilization systems, key aspects of the interaction of these components in complex formulations remain poorly understood, especially in acidic environments. In particular, most of the cited studies [7, 8, 9, 13] focus on achieving the maximum shelf life in ideal or strictly controlled conditions (for example, at a constant temperature of 4–8°C), which often does not correspond to real practice in the kitchens of public catering establishments. For the latter, the indicators of organoleptic,

mechanical and oxidative stability during temperature fluctuations in the refrigerator, with frequent opening and closing of the container, when stored in non-hermetic containers for a limited period of use are critically important. The introduction of prebiotic additives can significantly affect these indicators, since they can act not only as a functional ingredient, but also as a technological modulator, affecting the stability of the system under stressful storage conditions. Therefore, the most promising direction for further research should be considered the study of the influence of prebiotic additives on stabilizing systems that combine different types of emulsifiers and stabilizers, precisely in conditions that simulate real operation in HoReCa. Such a study should take into account not only the physicochemical stability of the emulsion at different pH values, but also its behavior under cyclic temperature changes and limited storage time, which are typical for the HoReCa segment. The results obtained will fill the gaps in scientific knowledge regarding the behavior of prebiotic additives in complex food matrices and deepen the understanding of the processes of forming functional food systems adapted to the needs of foodservice.

3. The aim and objectives of the study

The aim of the study is to determine the influence of the composition of prebiotic additives (inulin and oligofructose) on the technological and sensory characteristics of emulsified sauces-dressings in the HoReCa sector. The data obtained will allow to substantiate the optimal ratios of prebiotics for partial or complete replacement of sugar, maintaining emulsion stability at pH 4.5–5.5 and improving the functional properties of products without compromising taste. The results will contribute to the development of innovative recipes adapted to the requirements of modern foodservice (reducing sugar, increasing useful value).

To achieve the aim, the following objectives were solved:

– to establish a correlation between the concentration ratio of inulin: oligofructose and indicators of physical stability and rheological characteristics of emulsions;

– to evaluate the sensory profile of sauces-dressings with prebiotics compared to the control sample;

– to assess the economic feasibility of using prebiotic additives in the production of sauces and dressings for HoReCa.

4. Materials and methods of the study

4. 1. Object and hypothesis of the study

The object of the study is the process of forming the quality characteristics of emulsion sauces-dressings for the HoReCa system, enriched with prebiotic additives.

The main hypothesis of the study is the assumption that a rational combination of inulin and oligofructose can ensure emulsion stability due to the synergy of their hydrocolloid properties and maintain the desired rheological characteristics without additional stabilizers. Also, this combination is able to imitate the sweetness profile of sugar, while maintaining the purity of taste, and increase the functional value of the product due to the prebiotic effect, which meets the requirements of the HoReCa sector.

The following assumptions are made in the study. First, the binary composition of inulin and oligofructose is able to ensure emulsion stability due to the synergistic hydrocolloid effect, maintaining rheological properties for 7–10 days at 4 °C. Secondly, the rational ratio of these prebiotics allows to achieve a sweetness profile similar to 3–5% sucrose, without disturbing the taste balance in systems with pH 4.5–5.5.

The study adopted a simplification: the model system is based on a standard oil phase, which ensures the representativeness of the results for most HoReCa sauces and dressings. The properties of the emulsifier (lecithin) are considered stable and independent of pH in the studied range.

4. 2. Materials used in the experiment

The following materials were used during the research:

– Orafti®GR inulin (chicory root extract, prebiotic fiber content: ≥ 90 % dry matter, manufactured in Belgium), according to DSTU-N CODEX STAN 192/CAS 9005-80-5;

– Fibruline™ oligofructose (product of enzymatic hydrolysis of inulin) (manufactured in Belgium), according to DSTU-N CODEX STAN 192/CAS 308066-66-2;

– liquid soy lecithin (manufactured in Ukraine), according to DSTU 4597/CAS 8002-43-5;

– refined corn oil (manufactured in Ukraine), according to DSTU GOST 8808/CAS 8001-30-7;

– refined hemp oil (produced in Ukraine), according to TU U 10.4-39224310-001/CAS 89958-21-4;

– citric acid (produced in Ukraine), according to DSTU GOST 908/CAS 77-92-9;

– distilled water (produced in Ukraine), according to DSTU ISO 3696/CAS 7732-18-5.

4. 3. Method of obtaining model samples of sauce-dressing

Model samples of sauce-dressing were obtained by stepwise formation of an emulsion, adapted to the technological capabilities of commercial kitchens. At the first stage, the oil phase (blend of oils) was heated to 35 ± 2°C in a boiler with jacket heating. In parallel, the aqueous phase was prepared: an acidity regulator (food grade citric acid “Extra”) was dissolved in filtered water at room temperature, adjusting the pH to 4.5–5.5. To form an emulsion, the oil phase was introduced in a thin stream into the aqueous phase with intensive mixing with an overhead blender (1500–2000 rpm) for 3–5 minutes until a homogeneous creamy consistency was achieved. The initial composition of the model sample of the emulsion system was as follows:

– oil composition: 70.0% (hemp oil – 42.00%, corn oil – 28.00%, lecithin – 1.00 %);

– water phase (filtered water – 28.85%, salt – 0.3%, citric acid – 0.15%).

Prebiotic components (inulin and oligofructose) were introduced at the stage of preparation of the water phase, previously dissolving them in warm water (40°C) for complete hydration. The resulting emulsion was immediately cooled to 4–6°C and poured into airtight containers with tight lids for further research.

4. 4. Methodology for determining the technological characteristics of model samples of sauce-dressing

The stability of the experimental samples of sauce-dressing was determined by centrifugation at 1500 rpm for 5 minutes in accordance with the requirements of DSTU 4560. After that, the samples were subjected to heat treatment in a boiling water bath with subsequent repeated centrifugation under similar conditions. The final stage of the study was the quantitative determination of the emulsion phase separation

index. The rheological characteristics of model samples of sauce-dressing were determined using a Rheotest-2 rotational viscometer (Germany). The study was carried out at a stabilized temperature of 20.0 ± 0.5°C, using a working gap between the cylinders of 1 mm.

4. 5. Methodology for evaluating the sensory profile of dressing sauces

The sensory profile of experimental samples of dressing sauces with prebiotics was evaluated in comparison with the control sample. The control sample (recipe "K") was identical in basic composition, but without the addition of prebiotic additives (inulin and oligofructose), which allowed isolating and clearly assessing the influence of these components. The principle of the method is based on assessing the intensity of taste and olfactory qualities, as well as textural properties by a group of tasters under controlled conditions of lighting, temperature and humidity. Each indicator was evaluated by comparison with reference samples, where a zero value corresponds to the complete absence of a feature, and the maximum score - to its bright expression. Statistical processing of the results was carried out using the principal components method to identify significant differences between the studied samples. The determination of the integral quality indicator was carried out by averaging the scores for all characteristics, taking into account their weight coefficient of importance for the overall perception of the product.

4. 6. Methodology for assessing the economic feasibility of using prebiotic additives in the production of sauces and dressings

The assessment of economic efficiency was carried out by means of a comparative analysis of the cost of the control sample (K) and experimental samples with prebiotics. Cost indicators are calculated per unit of finished product (€/t) with a breakdown for each component of the recipe.

4. 7. Research planning and statistical processing of results

The experiments were carried out in triplicate. To analyze the influence of the concentration ratio of inulin and oligofructose on the stability and viscosity of model emulsion systems of sauce-dressing, the method of multivariate regression was applied using the StatSoft Statistica *v.*12.0 software package (USA). The coefficients of the regression equations were determined by approximating the experimental data with an assessment of their significance using the Student's t-test ($p < 0.05$). The quality of the obtained mathematical models was assessed by the coefficient of determination. They were $R^2 = 0.954$ for equation (1) and $R^2 = 0.970$ for equation (2), respectively, which indicates a high degree of influence of variations in the concentrations of prebiotic additives on the stability and rheological properties of the model emulsion system. The significance of the regression models was confirmed by calculating the Fisher exact test ($F = 21.37$ for equation (1) and $F = 16.08$ for equation (2)), which exceeded the critical tabular value $F_{table}(2,12) = 3.88$ at $p < 0.05$, which allows to reject the null hypothesis with a probability of 95%. Multivariate analysis methods with the construction of response surfaces were used to visualize the results. Statistical data processing confirmed the adequacy of the obtained models and their suitability for predicting the quality of model emulsion systems in a given concentration range.

5. Results of determining the influence of the composition of prebiotic additives on the characteristics of dressing sauces in HoReCa

5. 1. Establishing a correlation between the concentration ratio of prebiotics and the quality indicators of the dressing sauce

The study of the influence of the concentration ratio of prebiotic additives inulin and oligofructose on the stability and viscosity of the dressing sauce was carried out using model samples of the emulsion system.

Using multivariate regression analysis, approximation equations were obtained that describe the dependence of the emulsion stability (ES ($C_{in.}$, $C_{ol.fr.}$),%) (equation (1)) and dynamic viscosity (DV ($C_{in.}$, $C_{ol.fr.}$), mPa s) (equation (2)) on the concentration of inulin ($C_{in.}$,%) and oligofructose ($C_{ol.fr.}$,%) in the natural values of the variables. The equations are valid in the range of inulin concentrations 2.0–5.0 % and oligofructose 2.0–6.0%:

$$ES\left(C_{in.},C_{ol.fr.}\right)=-40.49+36.68\cdot C_{in.}+15.55\cdot C_{ol.fr.}-$$
$$-3.14C_{in.}^2-0.95\cdot C_{ol.fr.}^2-0.83\cdot C_{in.}\cdot C_{ol.fr.},\left(R^2=0.954\right), \quad (1)$$

$$DV\left(C_{in.},C_{ol.fr.}\right)=-353.46+185.00\cdot C_{in.}+99.23\cdot C_{ol.fr.}-$$
$$-2.50\cdot C_{in.}^2-7.69\cdot C_{ol.fr.}^2-10.00\cdot C_{in.}\cdot C_{ol.fr.},\left(R^2=0.970\right). \quad (2)$$

The graphical representation of the obtained dependencies is shown in Fig. 1, 2.

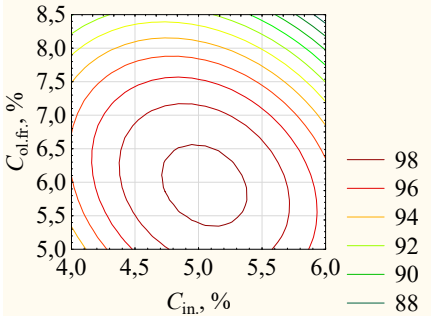

Fig. 1. Dependence of the stability of the model emulsion system on the concentration of prebiotic additives inulin and oligofructose

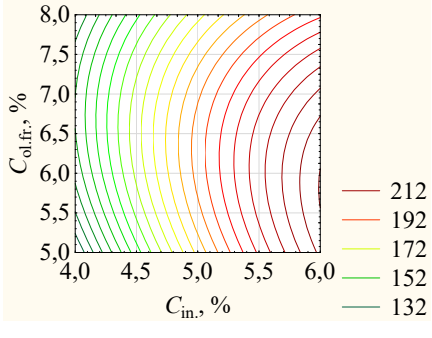

Fig. 2. Dependence of the dynamic viscosity of the model emulsion system on the concentration of prebiotic additives inulin and oligofructose

Graphical dependences (Fig. 1, 2) demonstrate a clear influence of prebiotic additives on the stability and rheological

properties of the model emulsion system of sauce-dressing. For inulin concentrations in the system, a pronounced nonlinear influence on the quality indicators of sauce-dressing is observed with a clearly expressed optimum concentration, while oligofructose exhibits a smoother influence. Special attention is paid to the ranges of maximum efficiency of each prebiotic component, where a combination of emulsion stability and dynamic viscosity is achieved. The results of mathematical modeling confirm the presence of a synergistic effect between the selected prebiotic additives.

5. 2. Evaluation of the sensory profile of dressing sauces with prebiotics compared to traditional analogues

The evaluation of the sensory profile of dressing sauces was carried out on two samples:

– control (model system of dressing sauce without prebiotic additives);

– experimental (model system of dressing sauce with the addition of 3.5% inulin and 4.0% oligofructose).

The choice of key parameters for sensory evaluation of products is justified by the specifics of the formation of the organoleptic profile of dressing sauces with hemp oil and prebiotics. Bitterness was chosen as an indicator of the oxidation of polyunsaturated fatty acids (PUFA), characteristic of hemp oil, while the intensity of the aroma reflects the ability of prebiotic additives to modulate volatile compounds of the oil phase. The creaminess of the texture of the dressing sauces was assessed due to the effect of prebiotics on the rheological properties, and the residual sensation was assessed for the duration and quality of the aftertaste. The balance of sweetness/acidity was taken into account due to the property of inulin to impart a faint sweetish tint, which can change the perception of acidity. A petal diagram was used to visualize the results of the sensory analysis (Fig. 3), which clearly demonstrates the complex effect of prebiotics on the organoleptic profile of the dressing sauces. This visualization method is especially relevant for the HoReCa segment, as it allows to quickly evaluate the product from the point of view of consumer qualities, which is critically important when forming the assortment policy of public catering establishments.

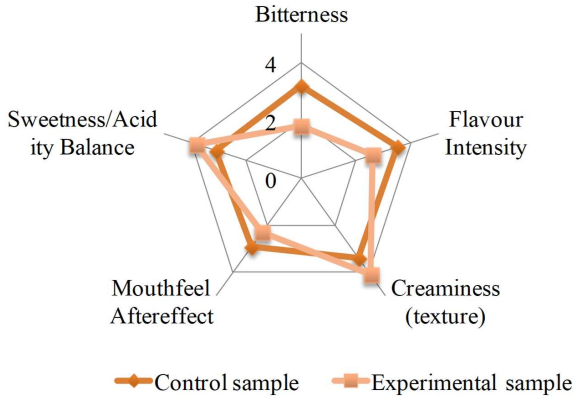

Fig. 3. Profile diagram of the quality of dressing with prebiotic additives compared to the control

It was found that the addition of prebiotics significantly affects the sensory profile. The diagram confirms that prebiotics reduce the intensity of undesirable characteristics (bitterness, residual feeling) and improve desirable qualities (creaminess, balance of flavors). The most pronounced changes were observed for the parameters of bitterness (decrease by 44%) and creaminess of the texture (increase by 21%). The results obtained indicate the effectiveness of using prebiotics to correct the organoleptic properties of hemp oil-based dressing sauces.

5. 3. Assessment of the economic feasibility of using prebiotic additives in the production of dressing sauces for HoReCa

To analyze the economic efficiency of using prebiotic additives in the production of dressing sauces, a comparative assessment of the cost of the control and experimental samples of dressing sauces was carried out. The cost indicators of raw materials are given in Table 1, taking into account market prices as of the fourth quarter of 2024.

Table 1

Comparative analysis of the cost of dressing sauces with prebiotic additives compared to the control

Component	Cost, €/kg	Content in product, kg/t	Cost in product, €/t
Control sample (base cost)			
Hemp oil	5.20	420	2184
Corn oil	1.80	280	504
Lecithin	4.50	10	45
Total:			2733
Experimental sample (additional cost)			
Inulin	8.00	35	280
Oligofructose	7.50	40	300
Total:			3313

The main cost components are hemp oil (79.6% of the cost of the control sample), corn oil (18.4% of the cost of the control sample), and prebiotic additives (17.5% of additional costs in the experimental sample).

6. Discussion of the results of determining the influence of the composition of prebiotic additives on the characteristics of dressing sauces in HoReCa

The analysis of the obtained approximation dependencies (1) and (2) indicates a significant influence of the concentration of prebiotic additives on the key technological characteristics of the model emulsion system. Equation (1) demonstrates that the stability of the emulsion of the model sauce-dressing system (*ES*) increases linearly with an increase in the content of both inulin and oligofructose, however, the quadratic terms of the equation indicate the presence of an optimum, which is especially pronounced for inulin (coefficient –3.14 at $C_{in.2}$). The interaction between the components (term $-0.83 \cdot C_{in.} \cdot C_{ol.fr.}$) indicates a synergistic effect when combining the indicated additives, and maximum stability is achieved at concentrations of 3.5–4.5% inulin and 4–5% oligofructose. In turn, the dynamic viscosity of the model system (*DV*), described by equation (2), has a somewhat more complex dependence. The linear coefficients of equation (1) (185.00 for the inulin concentration and 99.23 for the oligofructose concentration) confirm their ability to increase viscosity. However, the negative quadratic terms (–2.50 for the inulin concentration and –7.69 for the oligofructose concentration) indicate the appearance

of rheological instability at excessive concentrations. It is especially worth noting the significant negative complex effect ($-10.00 \cdot C_{in} \cdot C_{ol.fr}$), which indicates the competitive nature of the influence of these prebiotics on the emulsion structure when they are used together. Thus, the rational range of concentrations that provides a balance between stability and rheological properties lies within 2.5–3.5% for the inulin concentration and 3.0–4.0% for the oligofructose concentration. In the specified concentration range, a harmonious combination of the positive effect of prebiotin additives on emulsion stability ($ES > 92\%$) and a moderate increase in dynamic viscosity ($DV = 350–400$ mPa·s) is observed, which meets the requirements for the textural characteristics of dressings for HoReCa. The obtained results demonstrate the significant potential of the combination of inulin and oligofructose for modifying the technological properties of sauces-dressings, which is consistent with the literature data on the hydrocolloid properties of prebiotic additives [12].

As for the sensory characteristics (Fig. 3), the observed decrease in bitterness intensity by 44% compared to the control may be associated with the antioxidant properties of inulin, which is able to inhibit the oxidation of polyunsaturated fatty acids of hemp oil. However, additional studies are needed to confirm this mechanism, for example, determination of peroxide and anisidine numbers during the storage period. The improvement in the "creaminess" indicator by 21% may be a consequence of an increase in the viscosity of the emulsion system due to hydrated prebiotic fibers, which also requires further study of the rheological properties of the system.

Economic analysis (Table 1) reveals an increase in the cost of the developed product by 21.2% due to the introduction of prebiotic additives. To substantiate the economic feasibility and the possibility of positioning the product as premium, additional marketing research is needed on consumer preferences and willingness to pay a price premium for the functional properties of the product in the HoReCa segment. In addition, the claimed benefits in the form of reduced storage losses and improved logistics require experimental confirmation in real restaurant conditions.

The advantage of this study is a comprehensive approach to rationalizing the sensory profile of health-promoting sauces and dressings through the synergistic use of prebiotic additives – inulin (3.5%) and oligofructose (4.0%). Such a combined use of prebiotic additives provides an optimal balance between improving organoleptic characteristics (reducing bitterness, increasing creaminess), which makes the proposed solution particularly attractive for the HoReCa segment. An important scientific achievement is the demonstration of the possibility of effective use of valuable hemp oil in combination with prebiotics without loss of product stability, which opens up new prospects for the development of health-promoting food products.

The results of this study demonstrate significant differences from the approaches described in the literature. In contrast to the works [7–9], which investigated individual aspects of the stabilization of emulsion products, a comprehensive solution was proposed that combines prebiotic additives (inulin and oligofructose) with the traditional emulsifier lecithin in the composition of the sauce-dressing. While in the works [10–12] the main attention was paid to the technological properties of individual stabilizers, this study proved the synergistic effect of the combination of prebiotic components, which ensure simultaneous improvement of the organoleptic and technological characteristics of the product. An important difference is also that, in contrast to the studies [13, 14], which studied stability in a narrow temperature range, the authors evaluated the products in conditions as close as possible to real HoReCa practice. In addition, the work takes into account the influence of an acidic environment (pH 3.5–5.5), which has not been fully investigated in previous works, in particular [3, 15]. This allowed to develop a practical solution suitable for industrial application in the HoReCa segment. Compared with the literature data [7–9, 13, 14], the proposed approach is comprehensive, however, for its full validation, it is necessary to conduct comparative studies using traditional stabilization systems to assess the advantages of the proposed composition. One of the main limitations of this study is that the experiments were carried out on laboratory samples with a strictly controlled composition, which may differ from the real conditions of industrial production. This indicates the need for additional studies in industrial conditions with a longer observation period. In addition, the study was limited to only two types of prebiotic additives, while their combinations with other ingredients may affect the technological characteristics and sensory analysis results of the finished product. An important limitation of the work is also the lack of data on the effect of prebiotics on the microbiological stability of the product, since inulin and oligofructose can serve as a substrate for the growth of microorganisms. This issue is crucial for determining the real shelf life of the product in HoReCa conditions.

The disadvantage of this study is the lack of assessment of the effect of prebiotic additives on the microbiological stability of the dressing during long-term storage. Since inulin and oligofructose can serve as a substrate for the development of certain microorganisms, their introduction into the product composition is potentially capable of changing the microbiological profile and spoilage dynamics, which directly affects the shelf life. Of particular note is the possible stimulating effect of inulin and oligofructose on the reproduction of bacteria of the *Lactobacillus* and *Bifidobacterium families*, which, despite their beneficial properties, can lead to undesirable fermentation and pH changes. To eliminate this drawback, in further studies it is advisable to monitor microbiological indicators under conditions that simulate real HoReCa practice.

Further studies should be aimed at optimizing the concentrations of prebiotics for different types of oil compositions, in particular with an increased content of ω-3 PUFA.

7. Conclusions

1. The dependence between the concentration ratio of prebiotic additives inulin: oligofructose (3.5%: 4.0%) and the physico-rheological properties of a model emulsion system for sauces-dressings was studied. It was found that the proposed ratio provides a balance between physical stability and rheological characteristics. This is explained by the synergistic effect of the water-binding properties of oligofructose and the surface-active properties of inulin. It was experimentally confirmed that a further increase in the inulin concentration above 4.0% leads to an excessive increase in viscosity, which worsens the technological properties of the product. The results of the study create a scientific basis for the development of stable emulsion systems with health-promoting properties, adapted to the requirements of the modern HoReCa market.

2. The sensory profile of sauces-dressings with prebiotic additives was studied. Significant differences were found compared to the control sample. It was found that the com-

bination of inulin (3.5%) and oligofructose (4.0%) effectively reduces the bitterness of the product by 44% by binding free radicals formed during the oxidation of PUFA of hemp oil. At the same time, an increase in the creaminess of the texture by 21% is observed, which is due to the high water-binding capacity of prebiotic additives. Sensory analysis showed that prebiotic additives modulate the aromatic profile, reducing the intensity of herbal notes of hemp oil by 25%, and improve the balance of sweetness/acidity due to the sweetish aftertaste of inulin. The proposed combination of prebiotic additives provides a rational combination of improved organoleptic characteristics while maintaining product stability, which makes it promising for use in the HoReCa segment.

3. An assessment of the economic feasibility of using prebiotic additives in the production of sauces and dressings for the HoReCa segment was carried out. It was found that the introduction of inulin (3.5%) and oligofructose (4.0%) increases the cost of production by 21%. It is predicted that these costs can be offset by increasing the oxidative stability of the product, which reduces losses during storage, improving textural stability, which optimizes logistics costs, and the possibility of premium pricing for health products.

Conflict of interest

The authors declare that they have no conflict of interest regarding this study, including financial, personal, authorship or other, that could influence the study and its results presented in this article.

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Data availability

The manuscript has no linked data.

Use of artificial intelligence tools

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

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