

4.2 Scientific substantiation and development of rational modes of packaging paper flavoring

The study of trends in innovative development and production of products of the pulp and paper industry of Ukraine is an urgent issue of our time, since in Ukraine there are more than 2.6 thousand enterprises with about 40 thousand employees, producing more than 300 items of marketable products supplied to domestic and foreign markets. And this allows Ukraine to provide the population with jobs and maintain a competitive position in the global paper market [245].

According to the conclusions of the target program for the development of the pulp and paper industry of Ukraine and the domestic market of cardboard and paper products [246], one of the promising areas for further development is: expansion of the raw material base to increase the range of products with new properties; improvement and modernization of production to obtain a new product, etc.

Improving the quality of decorative wrapping paper will increase consumer interest in this type of product. Consumer properties that primarily affect the choice and demand of customers are aesthetic characteristics that can be seen visually. A positive impact on human impressions is effectively carried out through the visual organ, in particular due to the brightness and visual appeal of wrapping paper. This is also confirmed by the psychology of color in marketing, advertising and trade [247]. At the same time, it is well known that smells can directly affect and change a person's mood. In this case, certain aromas can have a specific effect, causing relaxation, excitement or increased sensuality. In aromatherapy, it is known about the influence of a number of essential oils on the emotional state of a person. Smells can be stored for a long time in the emotional memory of a person and activate it. As noted by modern scientists [248,249], the share of smells accounts for up to 10% of the effect that is recorded in the subconscious of a person when he or she gets acquainted with a new place, product or item, which is a significant percentage, given the influence of other factors, such as color, sound, etc.

Based on the above, the actual direction of the industry development is the aromatization of packaging paper, which will expand the range of relevant products and increase consumer interest. Aromatization with essential oils is not only a pleasant smell, but also a healing effect. That is, in this case it is important to positively influence a person through the senses

The aim of the work is to improve the consumer properties of packaging paper; scientific substantiation and development of rational modes and methods of impregnation of packaging paper with aroma compositions of essential oils.

To achieve this goal and conduct experimental studies, decorative wrapping paper was chosen, which has a variety of designs, colors, and patterns, as well as different structures. Such paper is mainly used for wrapping gifts and flower compositions (made of flowers that have an unexpressed aroma).

The implementation of the proposed technology for the production of wrapping paper with additional consumer properties is carried out by aromatization. To achieve the desired result, the following was carried out as part of the experimental work:

1. Creation of aroma-composition of essential oils "Christmas tree", which will be used for aromatization of wrapping paper.
2. Production of aroma composition with 100% concentration, with 75% concentration and 50% concentration of essential oils.
3. Impregnation of cotton plates with dotted application of aroma composition: the first plate - 100% solution in the amount of 1 ml, the second plate - 75% solution - in the amount of 1.25 ml, the third plate - 50% solution - in the amount of 1.85 ml.
4. Putting cotton plates in the lower compartment of three sealed boxes made of polyethylene terephthalate (PET).
5. Checking the strength of the aroma that will be collected in three boxes depending on the concentration of the aroma composition.
6. Selection of the required concentration of the aroma composition.
7. Placing the paper in the upper compartment of the sealed PET boxes.
8. Studying the effect of aging time and concentrations of aroma compositions on the quality of the developed samples of scented paper.

9. Studying changes in the stability of the aroma of samples of scented decorative paper.

In order to develop and improve the consumer properties of wrapping paper, namely to check the influence of the material on the strength of the paper aroma and the influence of the material on the duration of the aroma in the paper, five samples of wrapping paper were used, which differ in composition:

1. scented regular paper;
2. flavored corrugated paper;
3. flavored combined paper - covered with laminated foil on one side;
4. flavored combined paper - covered with metallized foil on one side;
5. flavored combined paper - covered on one side with a polyethylene layer.

A preliminary organoleptic evaluation of the quality of essential oils used to create the aroma composition "Christmas Tree" was carried out, the results of which are shown in Table 1.

Table 1.

Organoleptic evaluation of essential oils quality

Indicators	Requirements for products according to regulatory documentation	Essential oils				
		Pine	Fir	Spruce	Juniper	Cedar
Appearance	Liquid, homogeneous, transparent (no undissolved substances) consistency	Meets the requirements of regulatory documentation				
		liquid, homogeneous, transparent consistency				
Color	Intrinsic. The degree of intensity is characterized as colorless, weakly / intensely colored	Meets the requirements of regulatory documentation				
		colorless				light golden yellow

Continuation of table 1

Taste	Peculiar to this product, without foreign flavors	Meets the requirements of regulatory documentation				
		pronounced without foreign aftertaste	pronounced without foreign aftertaste	pronounced without foreign aftertaste	Strongly pronounced without foreign aftertaste	pronounced without foreign aftertaste
Smell	Peculiar, without foreign odors. Characterized by: odorless, with a perceptible odor	Meets the requirements of regulatory documentation				
		fresh forest, coniferous, with balsamic-woody smell	with a rich, persistent smell of fir, without foreign odors	a rich, fresh, resinous, typical coniferous smell	a characteristic rich, persistent smell of juniper	a persistent, rich balsamic cedar smell

All presented samples of essential oils have a liquid homogeneous transparent consistency. They have no color, that is, they are colorless, except for cedar, which has a light golden yellow color, which is inherent in this product. All samples have a pronounced taste without foreign flavors, except for juniper, which has a pronounced taste inherent in this product. The smell of the oils, which is decisive for the subsequent aromatization of wrapping paper, has a characteristic smell of the presented samples and is saturated strong.

Thus, the presented essential oils in all respects meet the requirements of regulatory documents and are of high quality.

The quality assessment of cotton plates to be used for impregnation with aroma composition is given in Table 2.

Table 2.

Commodity characteristics of medical hygroscopic cotton wool indicators

Indicators	Norm according to the regulatory document	Results of the research
Contamination, %, not more than	0,70	0,58
Content of foreign impurities: needles, chips, etc.	Not allowed	None
Ash content, %, not more than	0,40	0,37
Humidity, %, not more than	8,0	7,3

Continuation of table 2

Absorption capacity, g, not less than	67	68
Reaction of water extraction	Neutral	Neutral
Degree of whiteness, %, not less (for non-sterile)	66	68
The smell	Not allowed	None

As a result of the assessment of the quality of the cotton wool, the following was found out: the contamination, ash content and humidity of the cotton wool are within the normal range, there are no foreign impurities and odor, the absorption capacity and the degree of whiteness are higher than the standard, which is a positive indicator for this type of product, the reaction of the water extraction is neutral.

Consequently, medical hygroscopic hygienic cotton wool is of high quality and can be used for flavoring packaging paper.

The technical characteristics of the developed sealed PET box [250], which will be further used for the experiment, were carried out, the results are shown in Table 3.

Table 3.

Technical characteristics of the sealed PET box

Indicators	Characteristics
Appearance	A cylindrical box divided into two sectors - the lower one is small (a section for placing cotton wool impregnated with aroma composition), which is 1/15 of the height of the box and the upper one is large (a section for placing paper to be scented); the partition between the sectors is made of PET, which has holes placed evenly over the entire surface, 1 mm in diameter
Stiffness	High, the product does not bend, firmly held on a horizontal surface
Height, cm	The whole box 110, the lower part 7
Diameter, cm	20

The technical characteristics included: description of appearance, stiffness, color, height and diameter. The parameters of the box are taken into account the size of an average reel of paper.

To study the optimization of the formulation components, at the first stage, an aroma composition of essential oils "Christmas tree" was created, with the help of which the aromatization of wrapping paper was carried out. The aroma composition included: essential oil of pine, fir, spruce, cedar, juniper in equal amounts.

The next step was to prepare glycerin solutions of aroma compositions of different concentrations, namely: a solution with 100% concentration of essential oils, glycerin solution of aroma composition with 75% concentration of essential oils, glycerin solution of aroma composition with 50% concentration of essential oils.

After obtaining the aroma composition "Christmas tree" with the specified concentration of essential oils, the cotton wool plates were impregnated with a dotted application: the first plate - 100% solution in the amount of 1 ml, the second - 75% solution - in the amount of 1.25 ml, the third - 50% solution - in the amount of 1.85 ml and placed in the lower compartment of three sealed PET boxes.

The acquired aroma of wrapping paper was studied using the Guilford odor quality assessment scale in our own modification [251]. The developed scale for scoring the intensity of aromatization of packaging paper samples is shown in Table 4.

Table 4.

Scoring scale for assessing the intensity of aromatization of wrapping paper
samples

Number of points	Characteristics of the perceived odor
0	There is no smell
1	The smell is barely perceptible
2	The smell is weakly expressed, but perceptible
3	The smell is moderate, but not very intense
4	The smell is moderate, well expressed, not fully saturated
5	The smell is moderate, well expressed, moderately pleasant

Continuation of table 4

6	The smell is pronounced, very pleasant
7	The smell is pronounced, very intense
8	The smell is pronounced, but too intense
9	The smell is heavy, not very pleasant
10	The smell is very heavy, unpleasant

The next step of the research was to check the strength of the aroma accumulated in the boxes depending on the concentration of the aroma composition. The results are shown in Table 5.

Table 5.

Aroma strength depending on the concentration of aroma composition

Box with aroma composition	Characteristics of aroma in a box with aroma composition
100% concentration of essential oils	The smell is pronounced, very intense (7 points)
75% concentration of essential oils	The smell is pronounced, very pleasant (6 points)
50% concentration of essential oils	The smell is moderate, well expressed, not fully saturated (4 points)

The study of different concentrations of essential oils in the aroma composition "Christmas tree" was carried out in order to verify the feasibility of using the variant with 100% concentration for the aroma of packaging paper and the possibility of reducing the cost of this solution.

As a result of the study, it was found that the strength of the aroma of 100% and 75% concentration of the aroma composition is almost the same, and the strength of the aroma of 50% concentration did not give the desired result, as it had too weak a smell for further aromatization of wrapping paper.

Therefore, for further research, aroma compositions with a concentration of 100% and 75% were selected. The expediency of using these samples is determined taking into account the threshold of human sensitivity.

At the next stage of research, the dependence of the aging period and the

concentration of the aroma composition on the intensity of aromatization of wrapping paper in the upper compartment of a sealed PET box was checked. To do this, samples of wrapping paper were placed in the upper compartments of two sealed boxes with 100% and 75% concentration of aroma compositions for the same periods of time. The first test samples were taken out of the two boxes after 1 hour and checked the intensity of the aroma of the wrapping paper, which was flavored in boxes with different concentrations of aroma compositions. The following samples of paper were taken out of the two boxes at the following intervals: 3 hours, 6 hours, 12 hours, 24 hours, 36 hours, 48 hours and 72 hours. We noted the change in the intensity of the aroma and found out during what time the paper is completely aromatized and can be used. Based on the results obtained experimentally, we concluded that the aging time affects the aromatization of wrapping paper, but only up to a certain time. This time is the period during which the paper is completely aromatized and suitable for further use. Extending the aging time of the prototypes did not lead to an increase in aroma, further aging can be used for storage purposes.

Based on the study, it was found that the required period of exposure of wrapping paper in the upper compartment of a sealed box with 100% concentration of aroma composition for its complete aromatization was 24 hours, and in a sealed box with 75% concentration of aroma composition - 48 hours.

It was found that the material from which the wrapping paper is made also affects the degree of aroma of already flavored paper, but it is not advisable to increase the period of keeping the paper in the upper compartment of the sealed box, because the strength of aromatization depends on the composition of the paper, and not on the period of keeping the paper. It was determined that samples of plain paper and corrugated paper are characterized by the highest absorption capacity for aroma compared to other samples.

Subsequently, a study of changes in the stability of the aroma of samples of flavored wrapping paper was carried out. To test the stability of the aroma, the samples were stored for up to 48 hours indoors at a temperature of 18...20°C and relative humidity of 70...75%.

The paper samples were examined at the following intervals: 6 h, 12 h, 24 h, 36 h and 48 h. The time range was chosen taking into account the possible time interval between packaging and delivery of the product to the consumer. We note the change in the strength of the aroma at appropriate intervals. It was found that the samples of paper, which were kept in the upper compartment of the sealed box with 100% concentration of the aroma composition, retain a strong aroma up to 36 hours and only after this period they begin to lose the intensity of the aroma, but the smell remains up to 48 hours, but it is not intense enough. Paper samples treated with 75% concentration of the aroma composition retain a strong aroma up to 24 hours, and after this period begin to lose the aroma, but it does not disappear completely until 48 hours, but has a lower intensity than paper samples that were kept in an environment with 100% concentration of the aroma composition.

According to the results of the study, it was proved that the material from which the wrapping paper is made also affects the durability of the aroma. It was found that flavored plain paper and flavored corrugated paper retained the aroma for the longest time.

During the aging of these types of paper in 100% and 75% concentration of the aroma composition, their aroma remained intensely strong up to 36 hours. The pronounced aromatization of the paper remained up to 48 hours when using both concentrations, but had a slightly different intensity.

The obtained research results indicate that the treatment of wrapping paper by keeping it in a box with aroma composition allows to obtain flavored paper that does not lose its properties when used for 48 hours.

It was found that the rational period of keeping the wrapping paper in the upper compartment of a sealed box with 100% concentration of aroma composition for its full aromatization is 24 hours, and in a sealed box with 75% concentration of aroma composition - 48 hours.

The effect of dilution of the aroma composition from 100% to 75% concentration does not significantly affect the degree of aromatization of the paper, which makes it possible to reduce the price of this development when using 75% concentration of the

aroma composition.

It was determined that the material from which the wrapping paper is made affects the intensity of the aroma in the flavored paper: the most pronounced aroma was in plain paper and corrugated paper, and the intensity of the aroma in paper with a combined composition (covered with another material on one or both sides) is somewhat lower. This is due to the higher porosity and more pronounced sorption properties of plain and corrugated paper.

Thus, a method of aromatization of packaging paper has been scientifically substantiated and developed, which contributes to improving the quality, aesthetic expressiveness and satisfaction of consumer demand.