

Modern hair colouring techniques: Comparison of balayage, shatush and airtouch methods in choosing the optimal technique for clients

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Abstract. The aim of the article was to substantiate the optimal choice of partial lightening technique for different hair types through a combination of historical, chemical and applied analysis. The methodological logic covered a historical and chemical review of sources, an analysis of the classification of dyes and a comparison of three partial colouring techniques (balayage, shatush, airtouch) with an assessment of the impact on the hair. The main results showed that the transition from natural pigments to oxidative systems formed a classification according to depth of penetration and colourfastness; the technological parameters that determine the safety and durability of the result were systematised. For manual application with a stretch of colour, the nature of a soft horizontal gradation and moderate contact of reagents with the fibre was established; the typical correction interval was approximately from three to six months, the duration of the procedure was about 2-4 hours, and the degree of damage was assessed as low, provided that the exposure time was correctly controlled. For backcombing of strands, a diffuse vertical gradation, the ability to mask single grey hairs and correction intervals of about 4-5 months were determined; the duration of the procedure was 3-4 hours; the risk of damage increased under excessive mechanical impact. For air separation, the most delicate transition and the lowest load on the cuticle were revealed, the duration of preserving the effect was approximately 5-6 months with proper care, and the duration of the procedure was 4-6 hours, which correlated with a higher cost. Comparative analysis according to nine criteria showed the expediency of air separation for fine and weakened hair, backcombing of strands for dense or wavy structures, and manual application for medium density and naturally dark blond or chestnut bases. The practical significance of the work lies in the implementation of an algorithm for choosing a technique that takes into account the morphological characteristics of the hair fibre, the predicted duration of the effect, the intensity of chemical impact and the economics of the salon service

Keywords: colouristics; pigment; gradient; hair fibre structure; chemical load; porosity; methods of dye application

Сучасні техніки фарбування волосся: порівняння методів балаяж, шатуш та airtouch у виборі оптимальної техніки для клієнтів

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Анотація. Метою статті було обґрунтувати оптимальний вибір техніки часткового освітлення для різних типів волосся через поєднання історичного, хімічного та прикладного аналізу. Методологічна логіка охоплювала історико-хімічний огляд джерел, аналіз класифікації барвників і порівняння трьох технік часткового фарбування (балаяж, шатуш, airtouch) з оцінкою їх впливу на волосся. Основні результати засвідчили, що перехід від натуральних пігментів до окисних систем сформував класифікацію за глибиною проникнення та стійкістю

кольору; систематизовано технологічні параметри, що визначають безпечність і довговічність результату. Для ручного нанесення з розтяжкою кольору встановлено характер м'якої горизонтальної градації та помірний контакт реактивів з волокном; типовий інтервал корекції становив приблизно від трьох до шести місяців, тривалість виконання – орієнтовно 2-4 години, ступінь пошкодження оцінювався як низький за умови правильного контролю часу. Для начісування пасм визначено дифузну вертикальну градацію, здатність маскувати поодинокі сиві волосини та інтервали корекції близько 4-5 місяців; тривалість виконання – 3-4 години; ризик пошкодження зростає за надмірного механічного впливу. Для повітряної сепарації виявлено найделікатніший перехід і найменше навантаження на кутикулу, тривалість збереження ефекту – приблизно 5-6 місяців за належного догляду, тривалість процедури – 4-6 годин, що корелювало з вищою вартістю. Порівняльний аналіз за дев'ятьма критеріями показав доцільність повітряної сепарації для тонкого та ослабленого волосся, начісування пасм – для густих або хвилястих структур, ручного нанесення – для середньої густоти та природно рюсавих або каштанових баз. Практичне значення роботи полягає у впровадженні алгоритму вибору техніки з урахуванням морфологічних характеристик волоссяного волокна, прогнозованої тривалості ефекту, інтенсивності хімічного впливу та економіки салонної послуги

Ключові слова: колористика; пігмент; градієнт; структура волоссяного волокна; хімічне навантаження; пористість; способи нанесення барвника

Introduction

Hair colouring remained one of the most persistent sociocultural and technological phenomena, combining aesthetic, biochemical and hygienic aspects. Throughout history, changing hair colour performed the function of social identification and symbolic designation of status and cultural affiliation. However, the intensive use of synthetic dyes in the twentieth-twenty-first centuries raised questions about the safety of procedures, the chemical load on the hair and scalp, and technological ways of achieving long-lasting colour without damaging the structure of the hair fibre. It was precisely the need to combine colouristic stability and physiological safety that formed the basis for the study of modern colouring techniques that minimise the aggressive action of chemical compounds.

Scientific works demonstrate attention to the origin and properties of dyes. E. Alegbe and T. Uthman (2024) generalised the evolution of natural and synthetic dyes, classifying dyes according to structural characteristics and mechanism of action. The authors concluded that natural dyes, in particular those based on indigo and *Lawsonia inermis*, have a lower toxicological risk and help preserve the cuticular layer of the hair fibre, but are inferior to synthetic ones in terms of colourfastness. The work also noted that the future development of the industry is associated with combined systems that unite natural pigments and synthetic stabilisers. The toxicological aspect of dyes was revealed by L. He *et al.* (2022), who analysed more than fifty ingredients that form part of permanent dyes. The results showed that p-phenylenediamine, resorcinol and toluene can cause contact dermatitis and systemic reactions with prolonged use. The researchers noted that the degree of risk depends on the concentration of components, exposure time and the individual sensitivity of the skin.

The study by A. Tsimpidakis *et al.* (2024) highlighted the allergenic potential of components of colouring products. The authors systematised cases of sensitisation to dyes among patients of dermatological clinics and found that the most frequent allergens remain aniline derivatives, para-toluenediamine and nickel present in oxidative formulations. The conclusions of this work confirmed the need to search for methods that make it possible to minimise the use of chemical activators without losing colour intensity. The biochemical mechanism of natural hair pigmentation became the subject of research by C. Battistella *et al.* (2020), who reproduced the process of melanogenesis by synthesising melanin polymers. The authors proved that reproducing a natural pigment from biocompatible compounds makes it possible to create long-lasting colouring without ammonia and

oxidisers. The results of the study confirmed that the structural similarity of synthetic melanin to the natural one ensures high photostability and uniformity of tone.

Within the aesthetic and applied dimension, O. Savitska (2022) considered colouristic techniques as a component of hairstyle design. In the work, the author showed that gradient colouring methods – balayage, shatush and ombre – create the effect of natural light distribution and make it possible to form volume without sharp boundaries. The researcher's conclusions confirmed that it is precisely the plasticity of transitions that is an aesthetic sign of professional work with colour. This work laid the methodological foundation for the analysis of techniques from the point of view of the optical interaction of shades and the perception, depending on the hair type. The problem of creating safe and lightfast dyes with an ecological orientation was studied by T. Zhang *et al.* (2024). The authors proposed the concept of biomimetic systems that combine natural pigments with nanomaterials to stabilise colour without ammonia. The researchers proved that such a technology provides colouring duration up to 6 months without degradation of the shade under the influence of ultraviolet light.

In turn, D. Dashi (2021) focused on the development of new formulations for bleaching and toning hair, paying attention to reducing the aggressiveness of reactions. The study confirmed that colour stability depends not only on the dye formula, but also on the mechanical aspects of application – the method of distributing the mixture, the temperature regime and the duration of contact. The chemical mechanisms of dye action were revealed by A. Yıldırım *et al.* (2022), who classified the main reactions between precursors and oxidisers. The work confirmed that at elevated hydrogen peroxide concentrations, the disulphide bonds of keratin are destroyed, which reduces the strength of the hair fibre. The authors stressed that control of pH level and exposure time is decisive for preserving fibre structure.

The issue of the long-term impact of dyes on the body was studied by Y. Zhang *et al.* (2020), who conducted a large cohort study among women who regularly used permanent dyes. The authors concluded that chronic contact with phenolic compounds potentially increases the risks of certain types of tumours, particularly haematological ones. Although the statistical relationship remained relatively low, this result confirmed the need to replace aggressive oxidative systems with safer ones. It was precisely for this reason that the development of partial colouring methods with a limited area of chemical action acquired practical significance not only from an aesthetic, but also from a medico-biological point of view. The study of the morphological consequences of lightening procedures was carried out by R. Malkani *et al.* (2020). In the course of clinical and microscopic analysis, the researchers showed that after thermal and chemical exposure, the structure of the cuticle develops microcracks and the fibre thickness decreases. At the same time, with partial techniques, damage was recorded only in the upper layer of the hair, while the cortical part preserved its density.

Despite a significant number of studies, a number of issues remained open. No systematic comparison of the most widespread partial colouring techniques – balayage, shatush and airtouch – from the standpoint of the impact on hair structure, duration of effect and technological parameters had been carried out. This study was aimed at establishing correlations between the technological parameters of partial hair colouring techniques and the qualitative indicators of the resulting colour, structural changes of the fibre and the duration of effect preservation. To achieve the aim, the following tasks were defined: to trace the historical stages of the development of hair colouring technologies and the classification of chemical and natural dyes; to carry out an analytical description of balayage, shatush and airtouch techniques; to conduct a comparative analysis of the three techniques according to the criteria of duration of effect, degree of damage, cost, and suitability for different hair types.

Materials and methods

The study was based on systemic, comparative-analytical and morphological-technological approaches, which made it possible to analyse comprehensively hair colouring processes, the classification of dyes and the mechanisms of action of the three selected techniques – balayage, shatush and airtouch. The choice of these methods was determined by the representativeness for

modern professional practice, since these techniques covered three key models of partial lightening: manual application, backcombing of strands and air separation. These techniques combined different levels of mechanical impact, depth of dye penetration and degree of chemical load, which made it possible to establish correlations between the method of application and the degree of preservation of hair structure.

The initial stage of the study was aimed at creating a theoretical basis and determining the historical and scientific context. At this stage an analysis of archaeological and written sources was carried out, in which practices of changing hair colour in ancient cultures – in particular in Egypt, Greece, and Rome – were recorded. Within this stage, data on natural pigments (*Lawsonia inermis*, *Indigofera tinctoria*, copper and lead compounds) and on primary colouring technologies were systematised. This made it possible to establish the initial logic of the transition from natural to synthetic compounds and to reveal the socio-symbolic motives for the use of hair colour. The next stage consisted in determining the chemical mechanisms of hair colouring and in classifying types of dyes according to the level of penetration and impact on fibre structure. For this purpose, a structural-analytical method was applied, which included comparison of the component composition of permanent, demi-permanent, semi-permanent and temporary dyes. This stage was based on a review of the technical specifications of products presented in professional sources (Kashetsky *et al.*, 2021; Rust & Schlatter, 2022), as well as on comparing the properties according to pH parameters, hydrogen peroxide concentration, exposure time and degree of impact on the hair cuticle. The result was the creation of a comparative table, which made it possible to present systematically the mechanisms of action of different groups of dyes and to formulate criteria for choosing the technology for further research.

The third stage was devoted to the technical analysis of the three partial colouring methods: balayage, shatush and airtouch. At this stage an assessment was carried out of how the mechanical parameters of application (method of distribution, isolation, intensity of contact) affected the physical condition of the fibre and the duration of colour preservation. For this purpose, professional publications on the topic were used (WellaStore, 2021; The AirTouch Technique..., n.d.). In the course of this stage, a morphological and comparative approach was applied. For each technique, the following were determined: the method of preparing the hair; the characteristics of the dye composition; the application method; the average exposure time; the type of result. The fourth stage of the study consisted in determining criteria for assessing the impact of each technique on hair structure. The scientific basis at this stage was the work of S. Kwon *et al.* (2024). The method of expert analysis was used, within which observations regarding the degree of damage, elasticity, and shine of the hair after colouring were systematised. The focus of the analysis included the following indicators: the level of porosity after the procedure, the density of the cuticle (visually assessed smoothness of the surface), the preservation of natural shine and the frequency of necessary reconstruction procedures. These parameters were compared with technological characteristics – dye exposure time, oxidiser concentration, temperature regime and method of application.

The fifth stage was devoted to summarising the results in the form of comparative analysis. For this purpose, a synthetic method was applied, which involved combining technological, visual and operational characteristics. The comparison was carried out according to nine criteria: technological basis, contact with the dye, level of penetration, duration of effect, degree of damage, price, duration of execution, frequency of correction, optimal hair type. At this stage, the results were generalised to formulate conclusions about the functional advantages and risks of each method. The final stage of the methodological work consisted in formulating practical recommendations for colour specialists.

Results and discussion

Historical discourse and modern classification of colouring techniques

Humankind has been changing hair colour for millennia as a tool of social identification, aesthetics, and symbolism. Already in Ancient Egypt, hair colouring had not only decorative significance, but also indicated status, purity or ritual state. Archaeological finds, frescoes and burial complexes confirm the use of dyes in the third-second millennia BC. In Egypt, natural dyes were widely used

both for colouring hair and for pigmentation of wigs (Figure 1). In particular, henna (from the leaves of *Lawsonia inermis*) was used as a red-brown pigment (Ahmed, 2023). During mummification, henna was used to colour the hair cover of mummies as an element of the ritual.



Figure 1. Statue of Prince Rahotep and Rahotep's wife Nofret, c. 2600 BC, museum in Cairo
Source: Hair and Wigs in Ancient Egypt (n.d.)

In addition, for black or dark toning oxides of lead or sulphur compounds were sometimes used, in particular according to written recipes preserved from the Greco-Roman period – for example, pastes based on lead and slaked lime (Aufrère *et al.*, 2022). In Greece and Rome, hair colouring acquired additional social connotations. Some Greek texts mention the use of yellow, golden or reddish shades obtained from plants – for example, mixing henna with other pigments. In Rome, light (blonde) dye was popular among women of noble circles – this was largely due to the fact that blonde was associated with a foreign (Gallic) style. According to some sources, at a certain period Roman legal regulations even required prostitutes to dye the hair light in order to distinguish these women visually (Sanger, 2022). As for natural dyes, in addition to henna, antiquity used basma, coal dust, metal oxides and copper compounds. For example, indigo and other plant extracts could serve to create shades. In some cases, copper or metallurgical waste were used as additives – these metals could change the tone. In texts from the later Roman period there survive recipes that propose pastes from mixtures of lead oxide (PbO) and calcium hydroxide ($Ca(OH)_2$) for darkening grey hair – under the action of sulphur from keratin, PbS nanocrystals were formed, covering the hair with a dark coating (Pereira-Silva *et al.*, 2022).

These results correlate with the conclusions of S. Bhuvanewari *et al.* (2021), who considered plant dyes as an effective and safe alternative to synthetic formulations. The experimental observations confirmed that mixtures based on *Lawsonia inermis* and *Indigofera tinctoria* provided stable colour intensity while preserving the integrity of the cuticular layer. This effect was consistent with historical data on the use of natural dyes in ancient civilisations, where the combination of henna and basma created a natural red-brown tone without significant fibre damage. At the same time, S. Bhuvanewari *et al.* emphasised the need to standardise concentrations and exposure time, whereas archaeological samples demonstrate variability of proportions and methods. Thus, the convergence lay in the recognition of natural dyes as effective and gentle, and the difference – in approaches to controlling the stability and accuracy of formulas.

After the introduction of natural dyes and the widespread use in antiquity, the twentieth century was marked by a transition to synthetic compounds with more controllable properties. Already at the end of the nineteenth – beginning of the twentieth century the first oxidative dyes based on aniline derivatives appeared, which made it possible to change hair colour more radically than plant extracts (Chahande *et al.*, 2022). In classic formulations, ammonia was used as an alkaline component that opened the cuticle of the hair, allowing dye molecules to penetrate into the cortical zone, while hydrogen peroxide (developer) acted as an oxidiser that ensured the formation of the final pigment in the hair. In the development of chemical dyes stabilisers and buffer systems appeared that softened the aggressive effect on the hair, as well as more complex catalysts, precursors, and couplers.

Oxidative dyes often include small precursor molecules which, with the participation of peroxide, undergo an oxidation and coupling reaction with couplers inside the hair, forming molecules with a larger molecular size that “catch” inside the structure of the hair fibre (Kashetsky *et al.*, 2021).

The discovered transition from natural to synthetic components was consistent with the results of V. Palaniappan *et al.* (2024), who studied the dermatological risks of using ammonia dyes. The authors described allergic reactions and chronic skin damage caused by p-phenylenediamine and resorcinol compounds. This confirmed that stability and durability of colour were achieved at the cost of increasing chemical aggressiveness. In the study it was shown that permanent colouring provided maximum colour depth but required strictly regulated exposure time and oxidiser concentrations. Thus, the results of V. Palaniappan *et al.* and the present study coincided in the conclusion about the need to control composition and introduce buffer substances to reduce the irritating effect, although the authors’ work focused on skin reactions, whereas the present study focused on structural changes of the hair fibre.

The emergence of professional salon procedures took place in the middle of the twentieth century, when manufacturers of colouring products began to standardise components (for example, to set peroxide concentration, the percentage of alkaline component, the ratio of precursors/couplers). This gave rise to two-component mixing systems (dye + oxidiser) and established exposure times, temperature regimes and neutralisation intervals (Rust & Schlatter, 2022). Subsequently, modifiers (denatured alcohols, stabilisers, salts or solubilisers) were added to these systems to increase stability, reduce odour and regulate permeability. In such professional conditions, stylists could better control the effect of lightening or toning, root correction and colour gradation. This contributed to the emergence of specialised professional lines of dyes and care products. At the same time, a classification of colouring types by the chemical mechanism and duration of action gradually formed (Table 1).

Table 1. Characteristics of the main types of hair colouring in the twentieth-twenty-first centuries

Type of colouring	Dye penetration	Level of impact on hair structure	Duration of effect/stability	Typical result and possibilities
Permanent	Deep, to the cortex (inside the hair fibre)	High: the cuticle structure is temporarily disturbed; possible weakening of the hair with frequent use	6-8 weeks or longer (until full regrowth)	Complete colour change; possible lightening by 1-5 tones
Demi-permanent (toning)	Moderate, upper layer of the cortex	Medium: minimal cuticle damage, gentle effect	4-6 weeks	Slight darkening or change of shade; without pronounced lightening
Semi-permanent	Superficial or minimal	Low: the cuticle does not lift, no oxidiser	2-4 weeks	Temporary colour change, toning or restoration of shine; does not lighten
Temporary colouring	Superficial	Very low, without structural damage	1.5-4 weeks	Slight change of shade or decorative effect
Creative and mixed techniques (ombre, balayage, shatush, airtouch, babylights)	Local penetration (up to the middle of the cortex)	Moderate: partial cuticle disruption on individual areas	3-6 months (depending on hair growth)	Smooth colour transitions, effect of natural lightening, individual modelling of shades

Source: compiled by the author based on J. de Souza *et al.* (2025)

In permanent colouring, the change of colour occurs deep in the cortical area of the hair. Ammonia or other alkaline components are used to lift the cuticle, as well as an oxidiser (hydrogen peroxide) in the appropriate amount (for example, 3%, 6%, 9%, 12% depending on the required lightening). Precursors (for example, diamine substances such as p-phenylenediamine or other aminoaromatic primers) enter an oxidation reaction, forming intermediate radicals, which further react with couplers, forming new coloured molecules directly inside the hair (Kwon *et al.*, 2024). These molecules are large enough not to be washed out during shampooing. In toning technology, a

weaker oxidiser and/or an ammonia substitute (for example, monoethanolamine) are usually used as the alkaline agent. Toning by this method makes it possible to lighten the hair by no more than 1-2 shades, or to darken/change the tone without significant lightening of the base pigment. In classification works it is noted that demi-permanent oxidative dyes contain approximately 2 % peroxide, lower alkalinity and a milder effect. Semi-permanent and temporary colouring are usually based on non-oxidative dyes, that is, colour pigments already have a ready-made-coloured state and are applied superficially. Temporary colouring lasts about 2-4 weeks, semi-permanent – sometimes up to 4 weeks or slightly longer, depending on the pigment type and hair porosity. Creative and mixed techniques combine elements of permanent and superficial colouring, use local lightening or highlighting, tone gradation, manual application, air blowing and so on. These include ombre, balayage, shatush, airtouch, babylights and others. Such techniques make it possible to create smooth colour transitions or local effects without necessarily affecting the entire length of the hair.

In the context of the pursuit of gentler technologies with reduced chemical load, the conclusions of H. Cui *et al.* (2023) are important. The authors proved that natural pigments – in particular *Curcuma longa* and *Camellia sinensis* – under controlled temperature and pH showed high photostability and the ability to colour hair evenly without the use of oxidisers. Such an approach correlated with the trend towards the development of ammonia-free or combined technologies in professional practice, which was identified in the results as a response to the damaging potential of aggressive compounds. The difference lay in the fact that H. Cui *et al.* carried out laboratory assessment of photostability, whereas the present study considered the applied effectiveness of partial colouring techniques – balayage, shatush and airtouch – in the context of minimising chemical stress on the fibre.

An important and illustrative example is the use of light blonde as an iconic style in the mid-twentieth century. For example, the transformation of Marilyn Monroe from naturally darker hair to bright blonde reflects the symbolic impact of colouring technologies of that time. In before-and-after photographs (a sharp contrast is visible between the natural tone and the fully coloured blonde) this demonstrates how aggressive oxidative colouring could change the base pigment (Figure 2).



Figure 2. Photo of Marilyn Monroe before and after dyeing blonde

Source: Bright Side (n.d.)

In summary, the evolution of hair colouring during the twentieth-twenty-first centuries passed from simple plant pigments to complex oxidative systems with advanced technological controls; along with the development of the salon segment and standardisation, a classification of colourings by mechanism and duration of action (permanent, demi-permanent, semi-permanent, temporary) appeared, and creative techniques emerged that combine different approaches.

Analysis of modern techniques of balayage, shatush and airtouch

The balayage technique is based on manual application of the colourant with a stretch of colour, that is, the stylist does not use foil, but intuitively “paints” lightened or darkened strands at an angle, which allows control of the intensity and length of transitions. This approach makes it possible to create the effect of sun-bleached strands – that is, lighter areas that gradually merge into the base tone of the hair without sharp boundaries. Instead of classic stripe highlighting with a clear contour, balayage aims at a gradual colour gradient along the length of the hair (Figure 3).



Figure 3. Balayage technique in caramel shades

Source: WellaStore (2021)

In technical terms the process begins with dividing the hair into zones (often vertical or diagonal sectors), after which the stylist, using a brush or comb, applies lightener or colourant in a thin line, stretching it downwards. The upper areas may remain almost untouched or be slightly lightened, and the lightening intensity increases towards the ends. Due to the open-processing method, where the colourant is left without foil or with light isolation, penetration of the agent occurs gradually – the hair cuticle does not open completely, and the action of the substance spreads from the middle of the strand to the end. Thanks to this, the lightening effect is less aggressive than with classic foil techniques with a high percentage of oxidiser. Practitioners of balayage also use different application variations: “V-balayage” methods (when two sides of a cone go from the root) or combined approaches to evenly distribute darkening or lightening across the whole head (Figure 4).

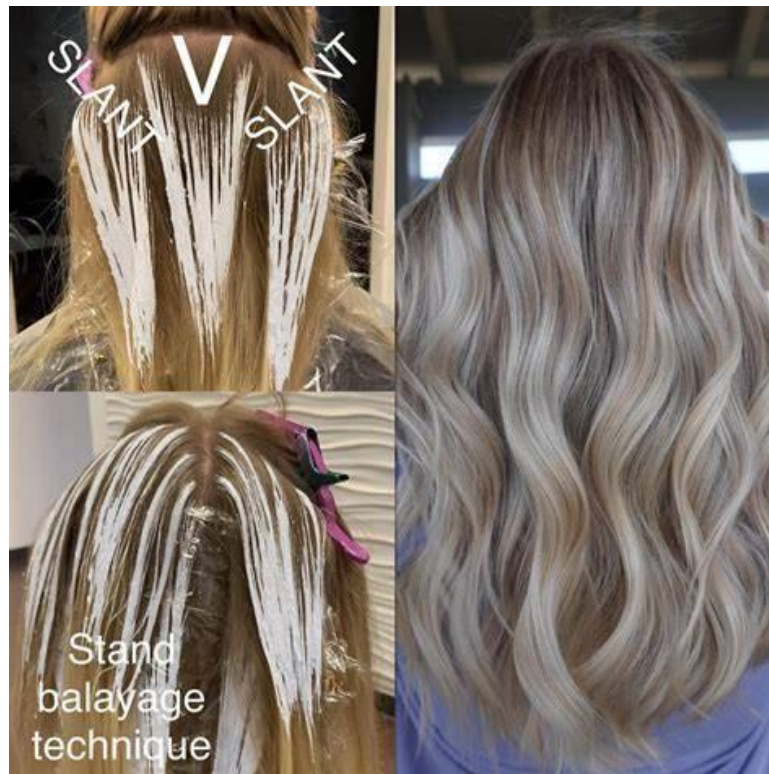


Figure 4. Example of the “V-balayage” technique in cool shades

Source: S. Ivett (n.d.)

The visual result of balayage is characterised by a smooth transition between the base shade and the lightened areas, without sharp lines. This effect gives the hair volume, as lighter areas create a play of light and shadow, but do not look like textured sections, as can sometimes occur with traditional highlights. The lightened strands imitate natural sun-bleaching, especially at the ends, while the root area contacts the colourant less, which extends the interval between corrections. Because of this the regrowth looks softer, transitions are less noticeable and the need for frequent root retouches decreases (compared with traditional stripes).

Regarding hair type for which balayage may be particularly effective, several parameters should be taken into account. The ideal option is hair of medium density – not too fine, so that lightening does not thin the structure, and not too thick, so that transitions are not lost in the mass. A base in a natural dark blond or chestnut tone is advantageous, since these colours have medium pigmentation, which provides a buffer for lightening without excessive aggression to the fibre. If the base is very dark, the lightener has to be strengthened, which may increase the risk of damage. If the base is very light, the transition effect may not be pronounced enough. Thus, clients with dark or black hair may also use balayage, but with prior lightening or base correction. In cases with red or copper pigment (which has a stable chromophore), the application technology should consider pigment resistance and the possibility of tone correction (Hong *et al.*, 2021). From the perspective of structural damage, practical observations in salon practice indicate a minor impact of balayage on the hair fibre, especially compared with full lightening. This is explained by the fact that not the entire length of the hair is exposed to the lightener, and due to the open-processing mode the colourant works more gently. For example, preparation of the hair (detox, removal of mineral residues) before application significantly reduces cellular stress. Professional methods add stabilisation steps (for example, products that stop oxidation) after the main exposure to avoid excessive impact on the cuticle.

In addition, stylists adjust the consistency of the lightener (paste thickness) so that it does not leak between sections and does not create spots – this also reduces the risk of uneven structural damage. Despite this, with insufficient control of exposure time or combination with previously damaged hair there is a risk of dryness, brittleness, or porosity of the ends. In such cases it is recommended to introduce care procedures (masks, reconstructors) immediately after colouring. The

relationship between oxidiser concentration, exposure duration and fibre condition corresponded to the conclusions of I. de Moraes *et al.* (2024). Using atomic force microscopy, the authors showed that *bleaching* with high peroxide concentrations led to rupture of protein bonds and formation of micropores in the cuticle. These data confirmed observations on reduced damage levels in techniques with shorter colourant contact with the fibre – in particular in balayage and airtouch. The difference lay in the fact that I. de Moraes *et al.* studied traditional bleaching, whereas the present work analysed selective, partial methods that preserved hair structure without complete cuticle destruction. Regarding the need for correction, balayage usually requires less frequent adjustments than traditional full colouring or classic highlighting, especially in the case of correct planning of lightened zones and maintaining the sun-bleached effect. The concentration of the lightener may be selected so that the lightening does not reach the root area or is soft where regrowth is noticeable. Thus, the interval between corrections may range from 3 to 6 months, depending on hair growth rate, base colour and the desired level of contrast. In practice, clients with balayage often return once every six months or even less frequently, if root regrowth does not create sharp boundaries. Overall, balayage demonstrates a balance between aesthetic flexibility and relatively controlled impact on the hair, which makes it an attractive option in many cases.

From the perspective of operational characteristics, the range of inter-correction intervals established in the work (balayage 3-6 months, shatush 4-5, airtouch up to ~6) and the predominance of a natural effect correlated with real consumption practices described by M. Dhafiri *et al.* (2022). In the local study, the authors recorded high frequency of dye use, a significant share of self-performed procedures and a noticeable frequency of subjective adverse sensations (dryness, brittleness, skin irritation). The similarity lay in the conclusion that techniques with a soft regrowth contour reduced the need for frequent interventions and thus lowered the cumulative load on fibre and skin. The difference was determined by the perspective: in M. Dhafiri *et al.* social-behavioural indicators dominated, whereas in the present study priority was given to technological and morphological quality markers (porosity, shine, cuticle density). The comparison showed that adjusting the correction frequency through the choice of technique had not only aesthetic but also preventive significance, as it reduced the cumulative risk of damage, indirectly indicated by the empirical basis of the local survey.

The principle of the shatush technique consists in backcombing strands before applying the colourant, which allows only part of the hair surface to be intensively lightened, leaving other areas in partial contact with the dye. After backcombing, the stylist applies the colour or lightener without using foil or wrapping – in an open method. As a result, the colourant penetrates unevenly: part of the hair (which stands on the surface after backcombing) receives active contact with reagents, others – only tangentially or slightly, which creates a soft lightening gradient. This combination of initial fluffing of the hair and local application makes it possible to obtain thin, lightened streaks that gradually merge into the base colour of the strand (Figure 5).



Figure 5. Colouring performed in the shatush technique

Source: ClioMakeUp (n.d.)

The visual effect achieved by this method is often called natural diffusion or the “sunlight reflection effect”. Light strands, as if bleached by the sun, are arranged unevenly, with smooth transitions and without clear boundaries. With skilful execution, the hair looks as if it were lightened from within rather than simply coloured from above. Such effects contain multi-level colour play – lighter streaks on the upper layer, finer accents in the inner layers and the base tone at the root. Since the root area is not intensively involved, correction of regrowth is less noticeable. Shatush is positioned as a technology similar to balayage but with an even softer transition and less aggressive lightening.

Regarding the hair type on which shatush manifests itself most effectively, the following points should be taken into account. Hair with high density or wavy/curly structure especially benefits from shatush: backcombing allows the colourant to penetrate individual layers without processing the thick masses of hair uniformly. On thick hair, the diffused effect looks textured. For curly hair, backcombing helps the dye penetrate through the chain-like structure, lightening only the elongated upper strands, while the inner layers may remain more saturated. Another useful property of shatush is the ability to mask grey hair or partial pigment loss (Cunningham, 2021). Thanks to uneven lightening, grey hairs can be dispersed among multilevel tones without creating a monotonous grey layer, which is especially beneficial at the first signs of greying. One of the aims of using shatush is to smooth the contrast of grey hair, especially near the roots, without the need for full colouring.

Among the advantages of shatush are a more natural appearance than many other techniques, especially on a darker base, as well as greater flexibility in considering hair structure: the stylist may vary the intensity of backcombing and the density of application, regulating the degree of lightening. In addition, since the root zone is involved less or only slightly, the period between corrections may be longer and regrowth looks less noticeable. In practical work, shatush is popular among clients who seek a natural look without frequent interventions. However, there are disadvantages in execution, especially when the technique is performed without sufficient experience. The main challenge is a non-uniform result, when incorrect backcombing or too rough application of the colourant may create uneven spots where the colour appears too intense. In addition, if backcombing is too aggressive or repeated many times, there is a risk of damage to the hair cuticle – scratches, lifting of scales, which increases porosity and brittleness. Also, for clients with short hair or very fine hair the effect may lose

expressiveness, since backcombing and gradient will not manifest – fine hair may not hold diffusion, and short hair may not allow enough transitions to be created.

Detailing of damage mechanisms in lightening and toning showed that the exposure duration and oxidiser concentration were critical for preserving the cuticle; this corresponded to structural observations in balayage and airtouch and coincided with the data of Y. He *et al.* (2023). In that work, it was substantiated that oxidative processes caused degradation of proteins and lipids, increased porosity, changed pH modulation of the scalp and induced oxidative stress, whereas interventions such as antioxidants and *pH* correction were considered appropriate. The similarity lay in the cause-and-effect chain: reduction of exposure time and selective application limited proteolysis and disturbance of the lipid layer. The difference was in the focus, since Y. He *et al.* emphasised the pathobiology of damage and possible therapeutic/care strategies, whereas the present work emphasised technological prevention through the choice of partial colouring technique. The conclusions obtained mean that controlling the degree of oxidation per strand and exposure time was of primary importance for maintaining functional integrity of the fibre and scalp comfort.

To minimise disadvantages, practice often uses combinations: shatush + toning with ammonia-free colourant to compensate for undertones or reduce contrast. Stylists carefully control the exposure time of the dye and the consistency of the paste (thickness, viscosity) to avoid leakage of the colourant through the backcombed sections. Some salons also introduce a neutralisation step or use products that stop the oxidative process before completion in order to preserve the cuticular layer of the hair. In summary, shatush is a method that uses initial backcombing of the hair before open application of the colourant to obtain soft lightened accents with a smooth transition characteristic of the sun-faded effect. It has advantages for thick and wavy hair, the ability to mask grey hair and a less aggressive nature of corrections. However, its implementation requires technical mastery and careful control of time and application force to avoid unevenness or damage. The visual parameters described in the shatush technique were consistent with the trends analysed by R. Potgieter (2021). The author noted that seasonal colouring directions showed stable demand for natural transitions and the “sunlight reflection” effect, which was formed using balayage and shatush methods. Both approaches defined naturalness and softness of tone as the main aesthetic criteria. These observations confirmed the obtained results regarding minimal need for correction and balanced colour transition, while R. Potgieter focused on fashion trends and consumer preferences, and the present study – on the technological nature of such effects.

The technological essence of airtouch lies in using blow-drying of strands to preliminarily separate short and inner hairs (baby hairs, inner layer) before applying the colourant. In the standard method, the ends of the hairs under air pressure are directed downwards or removed from the main colouring area, thus leaving only the longer strands to be lightened or toned (Figure 6). In other words, the hairdryer acts as a selection tool – the short hairs are blown out, the longer ones remain for colouring. Then a mixture (lightener or colourant) is applied to the selected mass of hair with controlled exposure and isolation. The method essentially creates colour gradation without classic backcombing as in shatush or balayage with backcombing technique (The AirTouch Technique..., n.d.).



Figure 6. Result of performing the airtouch technique

Source: Hera (n.d.)

Such preliminary separation of the hairs makes it possible to achieve maximally soft transitions, since the colourant comes into contact with the surface of the longer hairs, while the inner or shorter ones remain less processed or are not subjected to colour change. As a result, the transitions between the base colour, the lightened areas and the mid-tones become delicate and barely noticeable. In addition, due to the reduced amount of hair that directly contacts the chemical agents, the load on the cuticular structure decreases. The colour result is distinguished by depth – a spectrum of tones with internal nuances, a light absorbed shine and multidimensionality of the colour layer (tone, tone-undertone, transitions). Airtouch is considered quite a universal technique in relation to hair type. It is particularly advantageous for hair with signs of previous processing or damage, since mechanical intervention is minimal and the contact with the colourant is reduced. The technique adapts well to fine or normal hair, as the delicate removal of shorter hairs before application prevents excessive areas of colouring on sensitive fibres. Airtouch is also recommended for clients who have damaged hair or hair after previous colour treatments – thanks to the softer approach, the technique may reduce the likelihood of further structural damage. Proper execution of airtouch may provide an effect that lasts up to 6 months or even longer, subject to appropriate care and a moderate hair growth rate.

However, the technique has its drawbacks, which should be taken into account in the analytical aspect. The first is the high duration of the procedure: since the air separation of the hairs and precise division into strands is labour-intensive, the entire process may take 4-6 hours (or even more for long hair or complex constructions). Such a time resource increases signs of fatigue in the stylist and may worsen quality under conditions of insufficient control. The second is the cost: due to the labour intensity, the need for careful control, tools (a powerful hairdryer, diffusers, air balance, etc.) and possible additional protective or reconstructive products, airtouch is usually more expensive than other lightening methods. In some professional salons, clients are informed that this is a premium procedure, and its price is justified by the quality of the transitions and the long-lasting effect. In addition, the technique requires high precision: an incorrectly designed direction of the airflow, too aggressive blowing or strands that are insufficiently tensioned may lead to uneven lifting of the colourant or gaps in the coloured areas. If the short hairs have not been sufficiently separated, the colourant may partially hit the hairs, creating non-uniformity. In some cases, long processing times or incorrect concentrations of colourants may also increase the risk of hair dehydration.

In everyday practice, stylists apply certain technical strategies to minimise the disadvantages. For example, the stylists use a cooled air stream when blowing out the short hairs (to avoid thermal stress), test strands at the beginning of the work, intermediate neutralisation before final toning, as well as protective additives (proteins, oils, strengtheners) in the colour formulations. In addition, stylists often combine airtouch with light toning using ammonia-free colourants to mute warm or yellow undertones after lightening. In summary, airtouch is distinguished among technologies by the use of air as a tool for selecting hairs before colouring, which makes it possible to obtain delicate, multi-level colour transitions with less stress on the hair fibre. It is suitable for a wide range of hair types, especially those that have already undergone treatments or have a weaker structure.

Comparative analysis, choice of technology and practical recommendations

A comparison of three techniques – balayage, shatush and airtouch – allows systematically identifying the technological, visual and functional differences (Table 2). All three methods belong to the group of lightening techniques with partial coverage, but differ in the method of preparing the strands, the nature of contact with the dye and the level of stress on the hair structure.

Table 2. The main differences between the techniques of balayage, shatush and airtouch

Criterion	Balayage	Shatush	Airtouch
Technological basis	Manual application of the colourant with a stretch of colour, without foil, in an open method	Backcombing of strands to create a diffused effect, application of the colourant without foil	Blowing with a hairdryer to separate short hairs; colouring only the long strands
Contact with the colourant	Superficial and partial, controlled in intensity	Uneven due to backcombing; gradual penetration of the mixture	Selective, with minimal contact of sensitive areas of the hair
Level of colourant penetration	Medium, up to the middle of the cuticle	Medium, with variable penetration	Local, predominantly superficial or partial
Duration of effect	3-4 months (depending on hair growth)	4-5 months; regrowth is barely noticeable.	5-6 months; gradual preservation of the colour
Degree of damage	Low with proper control of processing time	Moderate; risk of damage with excessive backcombing	Lowest of the three; short hairs are not exposed to chemical agents
Procedure cost (salon category)	Medium	Medium-high (depending on hair density)	High (due to duration and labour intensity)
Duration of execution	2-3 hours	3-4 hours	4-6 hours
Frequency of correction	Once every 3-4 months	Once every 4-5 months	Once every 5-6 months
Visual characteristics	Smooth stretch of colour; effect of sun-bleached ends	Diffuse gradation; effect of sunlight reflections	Maximally soft transition, multidimensionality of tone
Optimal hair type	Medium density, dark blond or chestnut hair	Thick or curly hair	Fine, weakened, damaged hair
Advantages	Minimal need for correction, natural transitions	Natural diffusion, ability to mask grey hair	Gentle action, long-term colour stability, softness of tone
Disadvantages	Limited lightening on dark bases	High dependence on the stylist's experience	High cost and long duration of the procedure

Source: compiled by the author

Each technique has its own technological niche, determined by the method of selecting strands and the degree of colourant action. Balayage is characterised as a technique with moderate lightening, optimal for hair of medium density where it is important to maintain a balance between colour contrast and a natural effect. Evenness of application is achieved precisely through manual modelling of the direction of the brushstrokes, which makes the colour more controlled. Shatush, on the other hand, is oriented towards creating diffused gradients through mechanical backcombing – this gives additional volume to thick strands and makes it possible to conceal the first signs of grey hair. Airtouch, in turn, provides the most delicate colouring among all three methods, since mechanical and chemical action

is limited to the long strands, while the short hairs do not come into contact with the reagents. Such selection minimises cuticle damage and ensures colour stability for a period of up to six months.

From a perspective view, the established expediency of mild regimes and preservation of the cuticle resonated with safety-oriented approaches to innovative colourants, and carriers presented by S. Coimbra *et al.* (2022), where the dermal safety of nanomaterials in hair and skin products was evaluated. The similarity lay in the aspiration to combine the effectiveness of colour formation with the minimisation of barrier risks: in the present study this was achieved technically (selective application, short exposure), whereas in S. Coimbra *et al.* – through materials science solutions (encapsulation, controlled release, assessment of penetration). The difference was determined by the level of analysis, since the results of this work were based on morphological-technological criteria of execution quality, whereas S. Coimbra *et al.* focused on regulatory-toxicological aspects and the need for validated safety protocols for pigments and nanomaterials. In summary, the indicated set of structural-optical patterns, technological parameters and safety approaches confirmed that a rational choice of technique (balayage, shatush, airtouch) is an effective tool for balancing between the aesthetic result and the preservation of fibre integrity and skin comfort. Visual differences between the techniques can be traced in photographic samples that reflect the features of the colour transition and the distribution of light accents (Figure 7).



Figure 7. Collage of colouring results in the techniques of balayage-shatush-airtouch (from left to right)

Source: Tviy Svit (n.d.), What's a Balayage? (2022)

In balayage the light areas are concentrated in the lower part of the hair, forming a horizontal stretch, whereas in shatush the lightening is placed more vertically and fragmentarily, creating an effect of natural fading. Airtouch, in turn, demonstrates a smooth, barely noticeable boundary between the base and lightened tone, while the ends appear lighter without local jumps. Visual analysis makes it possible to confirm that the degree of transition visibility depends not only on technological parameters, but also on the initial condition of the hair – its thickness, porosity, and the presence of previous colour treatments. General conclusions regarding the choice of technique depending on hair type are based on the morphological characteristics of the hair fibre and its reaction to chemical action. For fine hair airtouch is the most appropriate, since the short or new hairs are not subjected to lightening, which reduces the risk of brittleness and overdrying. For thick or curly hair, shatush proves to be effective: backcombing ensures a natural distribution of strands and allows the colourant to penetrate unevenly, creating natural optical depth and volume. Finally, for hair of medium density or naturally dark blond hair balayage is the most balanced option, as it does not require aggressive lightening and makes it possible to obtain a gradual change of tone without visible contrast between the base and the ends.

The initial interpretation of the visual effects showed that the smoothness of transitions, optical volume and “sunlit highlights” in balayage, shatush and airtouch directly depended on the morphological parameters of the fibre: diameter, state of the cuticular scales, porosity, and pigment distribution. These results were consistent with the conclusions of S. Nagase (2019), where it was emphasised that indicators of surface micro-relief, thickness and orientation of scales changed the scattering and reflection of light, forming the perception of smoothness and shine. The similarity lay in the explanation of the optical effect through the microstructure of the fibre: in the present study softer methods gave higher preservation of the cuticle and, accordingly, more stable shine, whereas in S. Nagase this was confirmed by models of the dependence of appearance on surface roughness. The difference was determined by the emphasis, since in the present study the key factor was technological (the method of strand selection and duration of colourant contact), whereas S. Nagase focused mainly on structural determinants of appearance regardless of a specific technique. Taken together, this means that the application technique was considered a controllable tool for influencing the same optical parameters that are determined by hair morphology; therefore, the importance of method choice increases for a given fibre type.

The correlation between the technological characteristics of the techniques and the visual parameters of appearance was confirmed by the results of O. Savitska (2022), who studied the relationship between hair, skin, and eye colour in hairstyle design. The author’s conclusions proved that harmony of colour and tone directly influences the perception of the image, which was consistent with the principle of individualising the choice of colouring technique. In the results of the present study it was established that balayage is advisable for hair of medium density, shatush – for thick or curly hair, and airtouch – for fine or weakened hair; O. Savitska similarly emphasised the need to coordinate colour and structure with the natural physiological parameters of the client. Thus, both approaches demonstrated the synergy of technical and aesthetic factors in forming a balanced result.

Conclusions

As a result of the study, it was established that the evolution of hair colouring technologies has a continuous line of development from natural pigments to complex combined chemical systems that combine controlled action and minimisation of hair fibre damage. The analysis of historical sources confirmed that colouring initially had ritual and social significance, and later became an element of aesthetic self-expression. Natural colourants – henna, indigo, basma and mineral additives – provided a relatively mild effect and did not disrupt the fibre structure, whereas with the appearance of aniline derivatives in the nineteenth century there was a transition to oxidative technologies that laid the foundation for modern salon chemistry. The results obtained showed that the classification of colourings by type of colourant penetration (permanent, demi-permanent, semi-permanent, temporary and mixed) reflects not only technological, but also dermatological safety parameters. Permanent colouring has the highest durability (up to 8 weeks and more), but is accompanied by the greatest degree of cuticular damage due to prolonged contact with ammonia and peroxide compounds. Semi-permanent and temporary methods, on the contrary, show a shorter duration of effect (2-4 weeks), but do not disrupt the protein bonds of the hair fibre.

Comparative analysis of the three modern techniques – balayage, shatush and airtouch – made it possible to identify key technological and visual parameters that determine the effectiveness in different hair morphotypes. The study results confirmed that balayage is a method with a moderate degree of influence on the fibre: the colourant penetrates to the middle of the cuticle, creating a smooth horizontal stretch of colour. The duration of the effect averages 3-4 months, and the need for correction is minimal. Shatush, on the contrary, is characterised by a diffuse vertical distribution of lightening achieved by backcombing the strands. This method provides optical depth of colour and an effect of natural fading, preserving the result for up to 4-5 months. Airtouch showed the lowest level of structural load: the short hairs blown out by the air stream do not come into contact with the chemical reagent, which minimises cuticle damage. According to the results of the study, it can be concluded that the choice of technique should be based on the morphological characteristics of the hair. For fine or weakened hair, airtouch is optimal, as it reduces the risk of brittleness due to selective

action. For thick or wavy hair, shatush remains the most effective, forming volume and natural texture. For hair of medium density and naturally dark blond shades, balayage is advisable, providing a harmonious combination of colour contrast and softness. Thus, the study results confirmed the interdependence between the physical parameters of the hair fibre, the depth of colourant penetration and the visual durability of the effect. The analysis of visual characteristics showed that the difference between the techniques is manifested not only in the distribution of colour, but also in the nature of light refraction.

The study has certain limitations related to the absence of quantitative laboratory measurement of the degree of hair damage for each technique. The conclusions obtained are based on generalised observations and characteristics, but further research should include instrumental assessment methods – spectroscopy, trichoscopy and morphological analysis of the fibre. In addition, it is advisable to expand the empirical base by involving different hair types in terms of ethnic and climatic parameters, which will make it possible to assess the influence of humidity, temperature, and photostability of colourants.

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