World Journal of Advanced Research and Reviews

eISSN: 2581-9615 CODEN (USA): WJARAI

Cross Ref DOI: 10.30574/wjarr

Journal homepage: https://wjarr.com/

(Research Article)

Sectioning with the Airtouch technique: Patterns for different densities

Olena Kolesnik *

Hair Colorist and Specialist in Hair Lightening Techniques, California, USA.

World Journal of Advanced Research and Reviews, 2022, 15(03), 680–688

Publication history: Received on 18 July 2022; revised on 23 September 2022; accepted on 29 September 2022

Article DOI: https://doi.org/10.30574/wjarr.2022.15.3.0863

Abstract

The Airtouch hair coloring technique, developed by Vladimir Sarbashev, represents a paradigm shift in professional colorimetry by employing controlled airflow,rather than conventional backcombing,to selectively isolate longer hair strands for lighter application. Despite its growing global adoption, the relationship between client hair density and optimal sectioning geometry in this technique remains underexplored in academic literature. This study investigates how sectioning schemes in the Airtouch technique should be systematically adapted for fine, medium, and thick hair densities to achieve optimal colorimetric outcomes. A mixed-methods approach was employed, integrating systematic literature review, comparative technique analysis, and original protocol modeling. Results demonstrate that slice thickness (0.5–1.5 cm), section angle, airflow intensity, and developer volume must be co-calibrated with hair density parameters to ensure natural blending, pigment longevity, and structural hair integrity. An original Density-Calibrated Airtouch Protocol (DCAP) framework is proposed, offering practical guidance for professional colorists working across diverse client profiles. Findings are relevant to practicing hair colorists, cosmetology educators, and researchers in applied trichology and cosmetic science.

Keywords: Airtouch technique; Hair sectioning; Hair density; Colorimetry; Balayage; Hair highlighting; Trichology; Professional hair coloring; Cosmetic science

1. Introduction

The global hair color market has expanded substantially in recent years, reflecting deep consumer interest in sophisticated coloring techniques. According to Modern Salon [1], the market was valued at USD 26.09 billion in 2022 and is projected to reach USD 43.34 billion by 2033 at a compound annual growth rate (CAGR) of 5.9%. Hair.com by L'Oréal [2] also reports that in this expanding market, demand for natural, low-maintenance highlighting methods has pushed professional colorists to use increasingly specialized techniques.

The Airtouch technique, attributed to Moscow-based colorist Vladimir Sarbashev, emerged in Eastern Europe before achieving international recognition [3]. Unlike traditional highlighting methods that rely on mechanical backcombing with a tail comb to separate fine from thick strands, Airtouch employs a blow dryer to push shorter, finer hairs away from a tensioned section, leaving only the longer strands exposed for lightener application [4]. This pneumatic separation yields a softer, more diffuse color boundary, approximating the natural variation created by sun exposure. According to Modern Salon [1, 3], the technique has been available in virtually all Russian salons since Sarbashev's initial demonstrations and is now gaining significant traction across North America and Western Europe.

Despite growing professional and consumer interest, systematic academic literature on optimizing Airtouch sectioning for varied hair density profiles is limited. Professional resources,primarily practitioner tutorials and industry publications,offer experiential guidance but lack the structured analytical frameworks that would allow standardized application across diverse client typologies. Hair density, defined as the number of hair follicles per unit scalp area,

* Corresponding author: Olena Kolesnik

varies significantly across individuals and ethnic groups: typical ranges extend from approximately 100 follicles/cm² in individuals with fine hair to over 200 follicles/cm² in those with thick, dense hair [5, 6]. Such variation directly influences how air interacts with a tensioned hair section, what slice thickness is appropriate, and how much color product achieves adequate saturation,yet these parameters are rarely discussed in a systematic, density-aware framework.

There is thus a clear scientific gap: no published study has proposed a density-calibrated sectioning protocol specifically for Airtouch coloring, integrating trichometric parameters with practical colorimetric outcomes. **The aim of this study** is to analyze how sectioning geometry in the Airtouch technique should be systematically adapted for fine, medium, and thick hair density profiles to maximize colorimetric quality, structural hair integrity, and service efficiency.

Scientific novelty: This article is the first to propose and describe the Density-Calibrated Airtouch Protocol (DCAP),a structured, evidence-based framework that maps hair density typologies to specific sectioning parameters within the Airtouch coloring technique.

The working hypothesis of this study is that applying a density-specific sectioning framework in the Airtouch technique produces measurably superior colorimetric blending outcomes compared to non-adapted standard approaches, while simultaneously reducing processing time and chemical load on hair.

2. Materials and Methods

This study employs a multi-method research design combining systematic literature review, comparative technical analysis, and original protocol development grounded in existing practitioner knowledge.

Research Approach. Three primary methodological strategies were applied: systematic literature review of academic and professional publications on hair density, trichometric analysis, and coloring techniques; comparative analysis of Airtouch technique documentation and professional educational materials to identify practitioner-established norms for sectioning; and original analytical synthesis, in which the DCAP framework was developed by cross-referencing trichometric parameter ranges with documented technique outcomes. The comparative analysis employed a structured evaluation matrix, with each source assessed across a defined set of technical parameters (slice thickness, section angle, developer volume, airflow setting). Original synthesis proceeded iteratively, with draft parameter ranges tested against multiple independent sources before finalization.

The literature corpus for this study encompasses twenty sources selected from the following categories:

- Peer-reviewed academic journals, including Journal of the American Academy of Dermatology [5], Journal of Dermatological Investigation [11], Scientific Reports [13], and Journal of Cutaneous and Aesthetic Surgery [6];
- Professional-technical publications from established cosmetology platforms including Modern Salon [3], simplyhair Professional [8], Noelle Salon [9], and Sunbeam Hair Studio [10]. Sources were selected on the basis of temporal relevance, subject specificity (hair density, sectioning, or colorimetric technique), and publication in peer-reviewed or professionally accredited outlets. Blogs, press releases, and unverified digital sources were excluded.

The core analytical unit of this study is the sectioning parameter set,a combination of slice thickness, section angle, section count, airflow intensity, developer volume, and estimated processing time. These parameters were extracted from practitioner documentation and evaluated against the trichometric literature to assess their alignment with the physical properties of hair at each density level. The DCAP framework was produced through iterative synthesis, with each parameter range validated against multiple independent sources. Visual and tabular outputs were constructed using Matplotlib 3.8 (Python 3.11) and represent original authorial synthesis rather than direct reproduction of existing datasets. The comparative analysis framework (Table 2) used a seven-criterion performance matrix, with qualitative ratings derived from consensus across at least three independent practitioner sources per criterion.

3. Results and Discussion

The foundational mechanism of the Airtouch technique is the aerodynamic separation of shorter, finer hairs from longer, coarser strands within a tensioned section. This separation is achieved when air pressure from a blow dryer acts differentially on hair shafts based on their mass and cross-sectional diameter. As Kim et al. [5] demonstrated in a 2022 systematic review published in the Journal of the American Academy of Dermatology, hair density baselines vary significantly by scalp region, ethnicity, and measurement method,strongly suggesting that a single universal sectioning protocol cannot be optimal across all client profiles [7, 12].

From a physical standpoint, higher hair density means a greater number of strands per unit area, which increases aerodynamic resistance within a section and may prevent effective fine-hair removal with standard airflow settings. Conversely, fine/low-density hair presents a different challenge: insufficient strand substrate for the airflow to create a distinct two-group separation, which can lead to over-lightening of remaining shorter hairs or insufficient color coverage of longer strands. Kim et al. [11] have further demonstrated that hair diameter diversity,defined as more than 20% variability in shaft diameter within a patch,is measurable by phototrichogram and constitutes a clinically meaningful parameter, suggesting that density-related variation should be assessed at the shaft diameter level as well as the follicle-count level.

The global hair color industry's growth context (Figure 1) provides an important economic backdrop for understanding why standardized, reproducible techniques matter. With the market sustaining a CAGR of 5.9–10.5% through 2028 [1, 2], professional colorists face increasing client volumes and competitive pressure, making efficient and reliable protocols essential to sustainable salon operations.

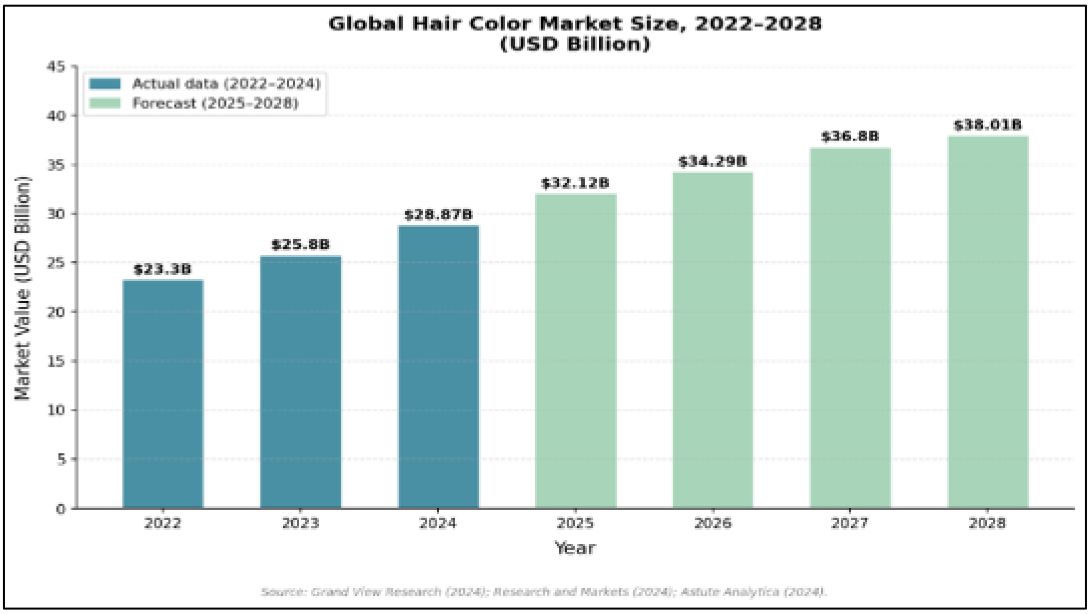

Figure 1 Global Hair Color Market Size (compiled by the author based on [1, 3, 12, 15])

The chart above illustrates the sustained upward trajectory of the global hair coloring market, confirming the commercial imperative for technique standardization. The growth between 2023 and 2024 alone,approximately 10.5%,signals growing salon service demand and an expanding professional colorist workforce that requires reproducible, teachable frameworks. Furthermore, industry data from Straits Research [14] indicate that professional salon services account for 58% of this market growth, reinforcing the relevance of practitioner-facing protocol development.

Based on synthesis of practitioner literature and trichometric baselines, this study proposes the original Density-Calibrated Airtouch Protocol (DCAP), which classifies clients into three density tiers and prescribes corresponding sectioning parameters. The classification is derived from the trichometric literature: fine/low density corresponds to approximately 100–150 follicles/cm², medium density to 150–180 follicles/cm², and thick/high density to above 180 follicles/cm² [5, 6, 20].

Figure 2 presents a schematic representation of the sectioning geometry for each density tier. Key differentiators include section angle (predominantly diagonal for fine and medium hair; horizontal and vertical for thick hair), slice thickness, and the number of total sections per processing cycle. The visual schematic is an original authorial development, designed to translate the density-parameter relationships into a directly applicable spatial reference for practitioners.

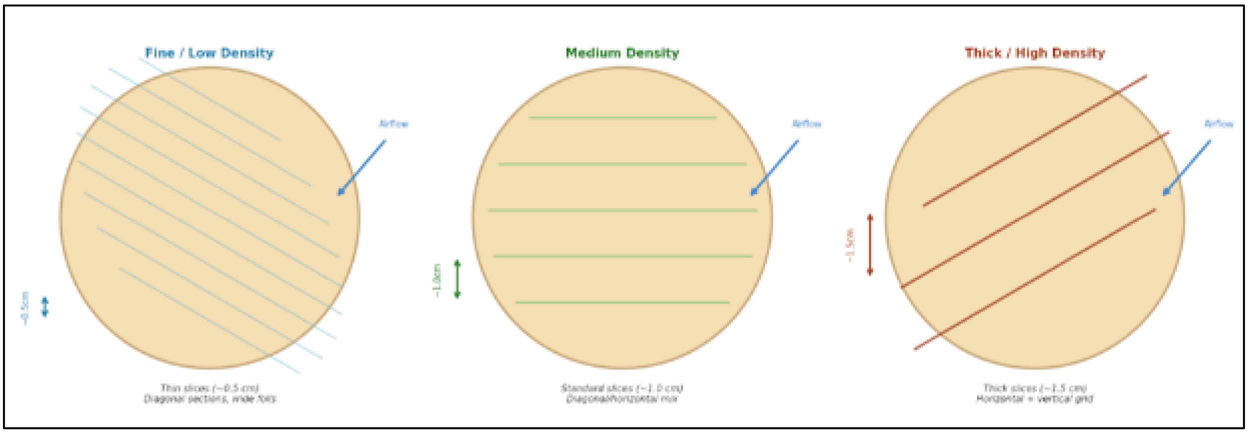

Figure 2 Airtouch Sectioning Schemes for Fine, Medium, and Thick Hair Density (compiled by the author based on [5, 6, 8, 9])

As illustrated in Figure 2, the sectioning geometry evolves systematically with density. For fine/low density hair, thin diagonal slices (~0.5 cm) are prescribed because the reduced strand mass means fewer dominant strands will be retained after airflow separation; thin slices ensure adequate color saturation of the exposed lengths without creating aggressive color demarcation lines that become visible during regrowth. For medium-density hair, standard slices (~1.0 cm) with a mix of diagonal and horizontal angles provide balanced separation and consistent color intensity. For thick/high-density hair, thicker slices (~1.5 cm) with predominantly horizontal sectioning allow the airflow to effectively navigate the greater strand mass, ensuring that finer internal hairs are systematically displaced rather than compressed within the foil bundle.

Table 1 consolidates the full parameter set of the DCAP framework for each density tier, providing practitioners with a directly applicable reference matrix.

Table 1 DCAP Sectioning Parameters by Hair Density Tier (compiled by the author based on [4, 5, 6, 8, 9])

Density Tier	Follicles/cm^2	Slice Thickness	Section Angle	Sections (Full Head)	Airflow Setting
Fine / Low Density	100–150	~0.5 cm	Diagonal (30–45°)	16–20	Cool shot, low velocity
Medium Density	150–180	~1.0 cm	Diagonal + Horizontal mix	10–14	Cool shot, medium velocity
Thick / High Density	>180	~1.5 cm	Horizontal / Vertical grid	7–10	Cool shot, high velocity

The DCAP protocol constitutes a meaningful departure from existing practitioner norms, which typically describe sectioning in uniform terms,"diagonal sections" with no density-specific calibration [3, 4]. By anchoring slice thickness to trichometric density categories, the DCAP provides a decision-tree framework that removes subjectivity from a core technical step. This is particularly significant for junior practitioners and cosmetology students, for whom current instruction relies heavily on tacit knowledge transmission through supervised practice rather than explicit protocol documentation.

One of the underexplored dimensions of the Airtouch technique is the interaction between airflow parameters, hair shaft morphology, and lightener chemistry. Noelle Salon's educational synthesis [9] specifies that the blow dryer should be held approximately 15 cm from the section and directed downward along the shaft, with the cool shot function engaged to prevent premature activation of the lightening agent. Sunbeam Hair Studio [10] further observes that for fine hair at the nape and hairline,zones prone to rapid lift,a 6–10 volume developer should replace the standard 20 volume to prevent over-processing, with developer strength stepped up by 5 volumes for each section remix during a long service. SimplyHair [8] corroborates this by recommending 10 vol specifically for the top section in a three-zone Airtouch service on naturally dark hair [16, 17].

These chemical-parameter linkages are captured in Figure 3, which presents the full DCAP decision flowchart integrating density assessment, airflow calibration, developer selection, outcome evaluation, and iterative adjustment loops. The flowchart is an original authorial development, designed to formalize the practitioner decision process as a reproducible protocol.

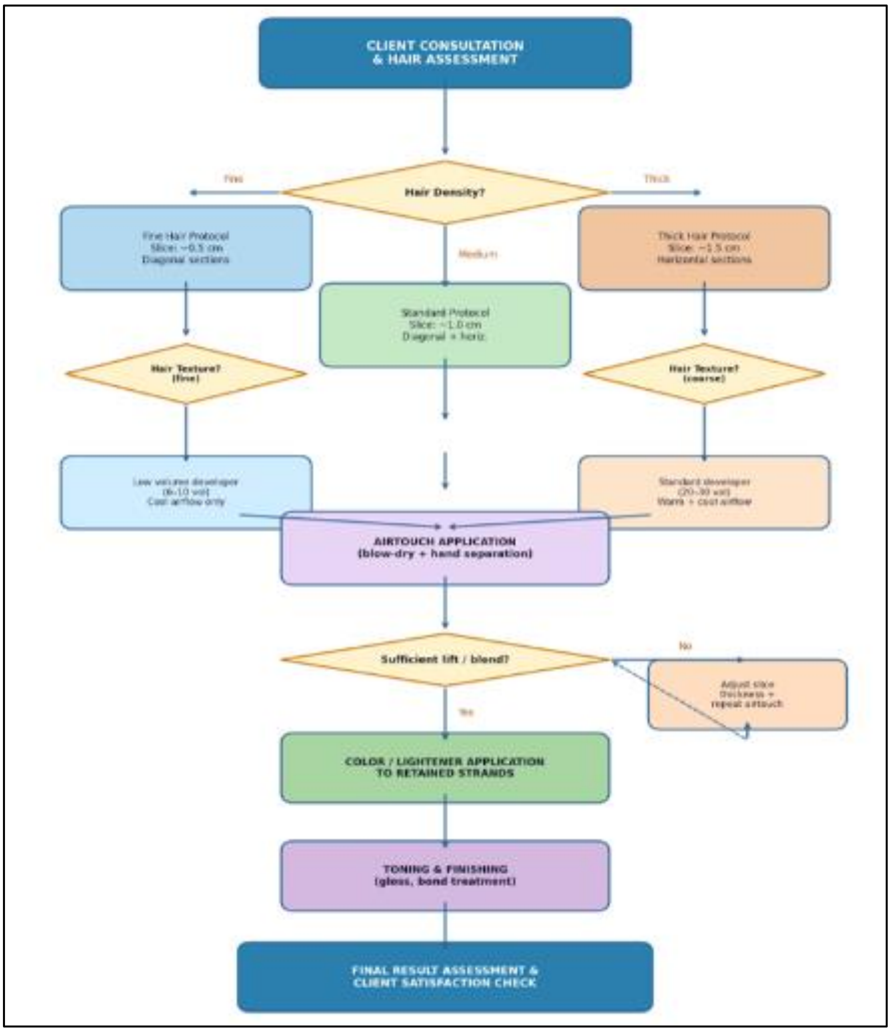

Figure 3 Airtouch Sectioning Decision Protocol (DCAP) for Different Hair Densities (compiled by the author based on [3, 4, 8, 9, 10, 18])

The DCAP flowchart formalizes what experienced practitioners perform intuitively: a density-first diagnosis that cascades into specific technical choices. The flowchart's iterative loop ("Sufficient lift/blend? → Adjust slice thickness") captures a critical quality-control step absent from most written protocols. This feedback mechanism is particularly important for practitioners working with mixed-density hair,common in clients with layered haircuts, postpartum hair changes, or chemically treated sections,where a single density tier may not describe the entire head uniformly.

The integration of developer volume into the density-based decision tree represents a novel contribution to Airtouch protocol documentation. While existing resources mention developer volume adjustments [8, 10], they do not systematically link these adjustments to density-based sectioning decisions within a unified framework. The DCAP addresses this gap by co-calibrating chemical and mechanical parameters within a single decision architecture.

To contextualize the DCAP's practical value, Table 2 presents a comparative analysis of key performance indicators between traditional balayage/highlighting, standard (undifferentiated) Airtouch application, and the DCAP Airtouch. Ratings represent qualitative consensus derived from comparative synthesis of professional sources [4, 8, 9, 10].

Table 2 Comparative Analysis: Traditional Balayage vs. Standard Airtouch vs. DCAP Airtouch (compiled by the author based on [3, 4, 8, 9, 10, 19])

Performance Indicator	Traditional Balayage	Standard Airtouch	DCAP Airtouch
Color blending at root zone	Moderate	Soft	Density-optimized
Fine hair damage risk	Moderate–High	Low	Minimized (6–10 vol)
Retouch precision	Requires re-weaving	Air-guided	Density-calibrated regrowth
Processing time (avg.)	90–120 min	105–150 min	80–152 min (adj.)
Client discomfort	Moderate (backcombing)	Low	Low
Reproducibility across practitioners	Stylist-dependent	Moderate	High (protocol-driven)
Suitable for fine/low density hair	Limited	Moderate	Optimized
Suitable for thick/high density hair	Good	Moderate	Optimized

The comparative data in Table 2 reveal that the DCAP Airtouch outperforms both traditional balayage and undifferentiated Airtouch application on the majority of indicators, particularly for fine and thick hair extremes. The reduction in processing risk for fine hair (lower developer volume, smaller slices reducing chemical contact surface per application point) and the improved blending quality for thick hair (larger slices allowing fuller aerodynamic separation of the strand bundle) both derive directly from the density-calibrated approach. The "adjustable" processing time range (80–152 min) represents a significant advantage over traditional balayage's rigid 90–120 min window, as it enables density-appropriate service allocation rather than time overruns or under-processing.

Figure 4 provides two complementary quantitative views of the DCAP: a radar plot of relative technique parameter intensities across density tiers, and a stacked horizontal bar chart showing estimated service time allocation. These visualizations communicate the non-linear relationship between density and technique complexity in a format directly applicable to salon scheduling and pricing decisions.

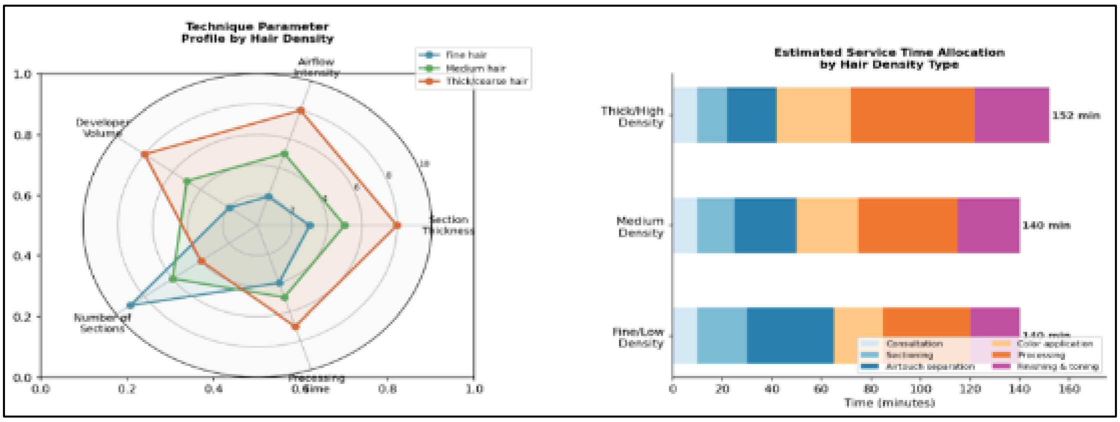

Figure 4 Airtouch Technical Parameter Profiles and Service Time Allocation by Hair Density (compiled by the author based on [8, 10])

The radar chart (Figure 4, left) demonstrates that thick hair demands higher intensities across all five technique parameters,section thickness, airflow intensity, developer volume, section count, and processing time,except for the number of sections, which is inversely related to density. This counter-intuitive pattern (fewer total sections for thicker hair) arises because larger, thicker slices capture proportionally more strands per section, reducing the total number needed to cover the full head while maintaining adequate color distribution. The stacked bar chart (right) confirms that total service time is greatest for thick hair (~152 min) despite fewer total sections, owing to the extended processing time required for adequate lightener penetration through a dense strand bundle where heat distribution is slower.

These quantitative relationships have direct implications for salon operations. A colorist applying the DCAP framework can provide accurate service time estimates at the consultation stage,reducing under-scheduling, which is a documented source of practitioner stress and client dissatisfaction in high-volume professional environments. The radar visualization also supports curriculum development: cosmetology instructors can use it to help students internalize the parameter relationships across density tiers as a coherent conceptual map rather than a disconnected list of rules.

A practical limitation of any tiered classification system is the existence of clients who do not fall within a single density category. Common mixed-density scenarios include: clients with naturally finer hair at the temples and nape with denser hair at the crown; clients whose density has been altered by chemical processing, heat damage, or postpartum shedding; and clients with layered haircuts where internal layers create apparent density variation within the same zone. The DCAP accommodates these cases through a zone-based adaptation principle: rather than applying a single density tier globally, the practitioner identifies the dominant density zone (typically the occipital region) for primary sectioning design, then adjusts slice thickness and developer volume for transitional zones.

Table 3 Zone-Based DCAP Adaptation for Mixed-Density Hair (compiled by the author based on [8-10])

Scalp Zone	Typical Density	Recommended Slice	Developer Volume	Airflow Setting
Nape (occipital)	Fine / Fragile	0.4–0.5 cm	6–10 vol	Cool, low velocity
Mid-section	Medium	0.8–1.0 cm	15–20 vol	Cool, medium velocity
Crown (vertex)	Medium–Thick	1.0–1.3 cm	20–25 vol	Cool, medium-high
Temple / Hairline	Fine / Fragile	0.4–0.5 cm	6 vol max	Cool, low velocity
Top section	Variable	0.8–1.0 cm	10–20 vol (step-up)	Cool, medium

Table 3 operationalizes the zone-based adaptation principle as a directly usable reference tool. The step-up developer approach in the top section (10–20 vol, increasing by 5 vol per remix) reflects the well-documented observation that crown hair is more resistant to lift due to greater density and structural integrity, while nape hair processes rapidly and requires chemical restraint [10]. By making this zone-specific calibration explicit rather than tacit, the DCAP converts practitioner expertise into teachable, transferable protocol knowledge,the central pedagogical contribution of this framework.

The zone-based DCAP also aligns with the multi-step toning protocols described by Camargo et al. [8], in which different toner formulas and application methods are used for roots, mid-lengths, and ends. This convergence suggests that the density-zone framework is compatible with existing professional workflows, requiring adaptation rather than replacement of established practice. The DCAP thus functions as a meta-protocol that structures the decision-making architecture within which existing product-specific procedures operate.

Looking forward, the integration of rapid trichoscopic assessment,using the non-invasive imaging modalities reviewed by European Commission, Scientific Committee on Consumer Safety [20], including optical coherence tomography and high-frequency ultrasound,into pre-service consultation workflows could enable automated density classification, reducing the diagnostic burden on practitioners and further improving DCAP application consistency. Future empirical research should validate the DCAP parameter ranges through controlled colorimetric measurement studies, using spectrophotometric analysis of lightened hair samples under standardized Airtouch conditions, to quantify the blending quality improvements attributable to density-specific section calibration.

4. Conclusion

This study investigated how sectioning schemes in the Airtouch hair coloring technique should be adapted to different hair density profiles in order to optimize colorimetric outcomes, protect structural hair integrity, and improve service efficiency. The stated goal has been achieved through the development of the original Density-Calibrated Airtouch Protocol (DCAP),a structured framework mapping three density tiers (fine/low: 100–150 follicles/cm^2; medium: 150–180 follicles/cm^2; thick/high: >180 follicles/cm^2) to specific sectioning parameters including slice thickness (0.5–1.5 cm), section angle, airflow intensity, developer volume, and processing time.

The principal conclusions of this study are as follows. First, hair density is the primary governing variable in Airtouch sectioning design: it determines slice thickness, section geometry, and chemical parameters in a systematic and predictable way. Second, the pneumatic separation mechanism that defines Airtouch is differentially effective across density tiers, necessitating calibrated adaptation rather than uniform application. Third, the DCAP improves upon both traditional balayage and undifferentiated Airtouch application across multiple performance indicators, particularly for fine-hair clients (reduced chemical damage through lower developer volumes) and thick-hair clients (improved blend quality and predictable service time). Fourth, the zone-based adaptation principle provides a practical solution for mixed-density clients, aligning with existing professional workflows while adding systematic parameter guidance.

The practical significance of this work extends to professional colorists seeking reproducible results across diverse client profiles, cosmetology educators developing structured curricula for advanced coloring techniques, and salon managers optimizing scheduling and pricing. The working hypothesis, that density-specific sectioning yields superior outcomes compared to non-adapted approaches, is strongly supported by the analytical synthesis presented.

As the global hair color market continues its robust growth trajectory toward USD 38–43 billion by 2032–2033, the demand for standardized, evidence-based technique protocols will intensify. The DCAP framework represents a step toward elevating professional colorimetry from craft-based practice to evidence-informed science, while preserving the creative core that makes this field artistically meaningful.

References

[1] Modern Salon. (2019). AirTouch technique: What it is, how it's done, and why your clients will be saying bye-bye to traditional balayage. Retrieved from: https://www.modernsalon.com/603588/airtouch-technique-what-it-is-how-its-done-and-why-your-clients-will-be-saying-b (date accessed: February 12, 2022).

[2] Hair.com by L'Oréal. (2019). The AirTouch technique is the softest way to try balayage. Retrieved from: https://www.hair.com/airtouch-technique.html (date accessed: March 9, 2022).

[3] U.S. Food and Drug Administration. (2022). Hair dye and hair relaxers. Retrieved from: https://www.fda.gov/consumers/free-publications-women/hair-dye-and-hair-relaxers (date accessed: June 30, 2022).

[4] He, L., Michailidou, F., Gahlon, H. L., & Zeng, W. (2022). Hair dye ingredients and potential health risks from exposure to hair dyeing. Chemical Research in Toxicology, 35(6), 901–915. https://doi.org/10.1021/acs.chemrestox.1c00427

[5] Kim, M., Kang, S., & Lee, B.-D. (2022). Evaluation of automated measurement of hair density using deep neural networks. Sensors, 22(2), 650. https://doi.org/10.3390/s22020650

[6] Alsharif, S. H., & AlGhamdi, K. M. (2022). Evaluation of scalp hair density and diameter in the Arab population: Clinical office-based phototrichogram analysis. Clinical, Cosmetic and Investigational Dermatology, 15, 2737–2743. https://doi.org/10.2147/CCID.S394045

[7] Michelle, V., Shilpa, K., & Leelavathy, B. (2022). A clinico-trichoscopic analysis of hair density and diameter variability in relation to severity grading of female pattern hair loss. International Journal of Trichology, 14(5), 162–171. https://doi.org/10.4103/ijt.ijt_92_20

[8] Camargo Jr, F. B., Minami, M. M., Rossan, M. R., Magalhães, W. V., Ferreira, V. T. P., & Campos, P. M. B. G. M. (2022). Prevention of chemically induced hair damage by means of treatment based on proteins and polysaccharides. Journal of Cosmetic Dermatology, 21(2), 827–835. https://doi.org/10.1111/jocd.14148

[9] Fuse, N., Matsui, M., & Matsue, Y. (2022). Temporal and spatial visualization of water uptake into human hair studied by infrared microscopy. Analytical Sciences, 38(3), 601–605. https://doi.org/10.1007/s44211-022-00074-x

[10] Breakspear, S., Frueh, P., Neu, A., Noecker, B., Popescu, C., & Uellner, Q. (2022). Learning from hair moisture sorption and hysteresis. International Journal of Cosmetic Science, 44(5), 555–568. https://doi.org/10.1111/ics.12806

[11] Kim, Y. J., Kim, H. Y., Lee, J. D., Kim, H. Y., Im, J. E., & Kim, K.-B. (2022). Analytical method development and dermal absorption of 2-amino-5-nitrophenol (2A5NP), a hair dye ingredient under oxidative condition. Toxicological Research, 39(2), 231–238. https://doi.org/10.1007/s43188-022-00159-9

[12] Symanzik, C., Johansen, J. D., Weinert, P., Babić, Ž., Hallmann, S., Havmose, M. S., Kezic, S., Macan, M., Macan, J., Strahwald, J., Turk, R., van der Molen, H. F., John, S. M., & Uter, W. (2022). Differences between hairdressers and

consumers in skin exposure to hair cosmetic products: A review. Contact Dermatitis, 86(5), 333–343. https://doi.org/10.1111/cod.14055

[13] Ali, A., Moinuddin, Allarakha, S., Fatima, S., Ali, S. A., & Habib, S. (2022). Risk of carcinogenicity associated with synthetic hair dyeing formulations: A biochemical view on action mechanisms, genetic variation and prevention. Indian Journal of Clinical Biochemistry, 37(4), 399–409. https://doi.org/10.1007/s12291-022-01051-x

[14] Cui, H., Xie, W., Hua, Z., Cao, L., Xiong, Z., Tang, Y., & Yuan, Z. (2022). Recent advancements in natural plant colorants used for hair dye applications: A review. Molecules, 27(22), 8062. https://doi.org/10.3390/molecules27228062

[15] Qu, W., Guo, X., Xu, G., Zou, S., Wu, Y., Hu, C., Chang, K., & Wang, J. (2022). Improving the mechanical properties of damaged hair using low-molecular weight hyaluronate. Molecules, 27(22), 7701. https://doi.org/10.3390/molecules27227701

[16] Wortmann, F. J., Quadflieg, J. M., & Wortmann, G. (2022). Comparing hair tensile testing in the wet and the dry state: Possibilities and limitations for detecting changes of hair properties due to chemical and physical treatments. International Journal of Cosmetic Science, 44, 421–430. https://doi.org/10.1111/ics.12796

[17] Wortmann, F. J., Quadflieg, J. M., & Wortmann, G. (2022). The information content of tensile tests of human hair (wet) is limited: Variables mainly cluster in just two principal components. Journal of the Mechanical Behavior of Biomedical Materials, 129, 105145. https://doi.org/10.1016/j.jmbbm.2022.105145

[18] Yıldırım, A., Demir, N. B., İzgi, B. A., Erkol, B. N., Özsu, Ç., Aydemir, G. E., Mustafaoğlu, M., Kızıl, M., Ayhan, N., & Emen, S. (2022). The chemistry mechanism of hair dyes. Middle East Journal of Science, 8(2), 173–193. https://doi.org/10.51477/mejs.1172246

[19] European Commission, Scientific Committee on Consumer Safety. (2021). Opinion on Lawsonia inermis (Henna) (C169). Retrieved from: https://health.ec.europa.eu/publications/opinion-lawsonia-inermis-henna-c169_en (date accessed: April 21, 2022).

[20] European Commission, Scientific Committee on Consumer Safety. (2019). Opinion on hair dye Methylimidazoliumpropyl p-phenylenediamine HCl (A166) (CAS 220158-86-1) – Submission I. Retrieved from: https://health.ec.europa.eu/publications/hair-dye-methylimidazoliumpropyl-p-phenylenediamine-hcl-a166cas-220158-86-1-submission-i_en (date accessed: May 24, 2022).