

RESEARCH ARTICLE

From Phytochemical Screening to School Health Literacy: A Comparative Study of Malachra Capitata Leaf–Flower Extracts and A Guidance-Based Model for Secondary Student Awareness of Antioxidant and Anticancer Science

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Abstract

This study integrates two traditionally separate domains—laboratory evaluation of plant-derived bioactivity and school-based educational guidance—by investigating the comparative antioxidant and anticancer potential of *Malachra capitata* extracts and translating key scientific concepts into an awareness-oriented framework for secondary-level learners. Building on classical documentation of forest minor products as sources of bioactive materials (Brown, 1921), the research first develops a comparative extraction and screening logic for aqueous and ethanolic preparations, emphasizing total phenolic quantification as an interpretable proxy for antioxidant potential (Singleton & Rossi, 1965) and discussing the rationale for in vitro cell-line reasoning in anticancer screening contexts (Niu & Wang, 2015). The biomedical component is positioned within contemporary methodological thinking that connects modeling and screening to iterative drug discovery pipelines, while also acknowledging that models and in vitro systems offer constrained but practically valuable windows into biological response (Carrara et al., 2017; Niu & Wang, 2015). The second component addresses the educational “implication” dimension by proposing a structured guidance-and-counseling delivery model to cultivate student awareness about health-related science, risk interpretation, and evidence-based decision-making in adolescence, drawing on established work about guidance services, student needs, and the effect of counseling interventions on school outcomes and discipline (Ajowi & Enose, 2010; Dash, 2003; Jaiswal, 2002; Jorge, 1968). The integrated findings are presented descriptively: ethanolic extracts are interpreted as the more likely phenolic-rich fraction based on solvent logic used in plant screening contexts (Singleton & Rossi, 1965; Irawan et al., 2021), while aqueous extracts are framed as potentially more acceptable for school demonstrations and safer conceptual translation for youth awareness contexts (Dash, 2003; Naik, 1997). A guidance-based awareness pathway is articulated to support age-appropriate scientific literacy and student self-concept around health learning, aligning with evidence that structured guidance programs can influence academic and psychosocial dimensions (Kamat, 1985; Dandapani, 1977). The study concludes that a comparative “bioactivity-to-awareness” approach can serve as a practical template for secondary education settings when accompanied by ethical, methodologically sound, and student-need-responsive counseling structures (Bhatnagar & Gupta, 1999a, 1999b; Best & Kahn, 2000).

KEY WORDS

Malachra capitata; phenolics; antioxidant screening; in vitro anticancer models; guidance and counseling; secondary education; health literacy.

INTRODUCTION

Plant-derived materials have long been treated as a practical bridge between local ecological knowledge and formal scientific inquiry, particularly in domains where communities and research institutions look for accessible sources of bioactive compounds (Brown, 1921). The contemporary resurgence of interest in botanical extracts for antioxidant and anticancer exploration has not eliminated the foundational issue that “bioactivity” is never a single property; rather, it is an interpretive outcome derived from methods, proxies, and models that each carry assumptions (Carrara et al., 2017; Niu & Wang, 2015). For secondary-level learners, this methodological reality is not merely a laboratory concern; it becomes an educational problem: how do students build awareness about health-science claims, understand what evidence can and cannot show, and develop a disciplined habit of interpreting findings without overgeneralization? Guidance and counseling traditions in school contexts have historically targeted discipline, adjustment, self-concept, and decision-making (Ajowi & Enose, 2010; Jaiswal, 2002; Madhukar, 2004). Yet, within many schooling environments, “health awareness” is presented as either moral instruction or superficial information, rather than as a structured literacy that links evidence, uncertainty, and personal decision-making.

This article takes the position that scientific awareness in adolescence is strengthened when it is not treated as an isolated curriculum unit but as a guided developmental task: students are helped to interpret claims, ask better questions, and connect learning to life without fear or sensationalism (Dash, 2003; Jorge, 1968). The educational literature included in the provided reference base consistently underscores that learner needs, counseling supports, and systematic programs can influence student outcomes (Bhatnagar & Gupta, 1999a, 1999b; Dandapani, 1977; Kamat, 1985). Meanwhile, biomedical references in the list highlight that anticancer discovery involves modeling and screening processes in which *in vitro* systems are used to approximate clinical response, albeit with recognized limitations (Carrara et al., 2017; Niu & Wang, 2015). The combined reference set therefore supports an integrative research goal: to construct a comparative, method-grounded screening narrative for *Malachra capitata* extracts and to translate that narrative into an educational guidance framework suitable for secondary awareness programs.

The present study is designed around three linked problems. First, in the biomedical domain, extract preparation is often discussed in a way that is inaccessible to non-specialists, even though the core logic—solvent selection, phenolic proxies, and comparative interpretation—can be explained in understandable terms (Irawan et al., 2021; Singleton & Rossi, 1965). Second, anticancer “potential” is commonly misunderstood in public discourse as a definitive property rather than as a preliminary indicator whose meaning depends on model systems and screening pathways (Carrara et al., 2017; Niu & Wang, 2015). Third, in educational practice, student awareness interventions can fail when they overlook developmental needs, school discipline contexts, and the role of structured guidance services in shaping student engagement and responsible decision-making (Ajowi & Enose, 2010; Dash, 2003; Naik, 1997).

Accordingly, this article pursues two integrated aims. The first is to provide a comparative assessment logic for aqueous versus ethanolic extracts of *Malachra capitata* leaves and flowers through interpretive phenolic screening (Singleton & Rossi, 1965) and an *in vitro* anticancer reasoning pathway grounded in the function of cell line models and drug discovery frameworks (Carrara et al., 2017; Niu & Wang, 2015). The second is to provide a guidance-based educational implication model that shows how schools can responsibly translate such evidence into student awareness—without exaggeration, fear appeals, or pseudo-certainty—by aligning content delivery with established counseling practices and student needs assessment traditions (Best & Kahn, 2000; Bhatnagar & Gupta, 1999a, 1999b; Jorge, 1968).

METHODOLOGY

The research is presented as an integrated design composed of (a) a comparative laboratory screening plan and (b) a school-oriented educational guidance translation plan. This mixed-logic structure is justified because the reference base itself spans biomedical screening methodologies and educational guidance program research, making an integrative approach more coherent than treating educational implications as an “afterthought” (Best & Kahn, 2000; Carrara et al., 2017).

Laboratory Design: Extract Preparation and Comparative Logic
The laboratory component is framed as a comparative

screening study focusing on two plant parts (leaves and flowers) and two solvents (aqueous and ethanolic). The rationale for solvent comparison is grounded in extraction principles used in plant bioactivity work, where solvent polarity influences the profile of extracted compounds and, consequently, the measurable phenolic content and related antioxidant signals (Irawan et al., 2021; Singleton & Rossi, 1965). While the provided references do not supply a plant-specific monograph for *Malachra capitata*, the inclusion of classic work on minor forest products supports the legitimacy of treating plant materials as candidate sources of useful compounds and of using comparative screening as an initial scientific step (Brown, 1921).

Operationalizing Antioxidant Potential Through Total Phenolic Proxy

Antioxidant potential can be operationalized through several laboratory assays; however, given the reference constraints, the study emphasizes total phenolic estimation via colorimetric reasoning, because the Folin–Ciocalteu style approach is a widely used proxy method and is directly supported by the classic methodological citation (Singleton & Rossi, 1965). Importantly, the study treats total phenolics not as “the antioxidant truth,” but as an interpretable proxy whose meaning depends on context, extraction decisions, and the limits of the chemical measurement (Singleton & Rossi, 1965). This framing is essential for later educational translation: adolescents can be taught that scientific measurement often uses proxies and indicators rather than direct access to complex realities (Dash, 2003; Jaiswal, 2002).

Operationalizing Anticancer Potential Through In Vitro Screening Reasoning

For anticancer potential, the study relies on the conceptual role of in vitro human cell line models as early-stage predictors of clinical response, while acknowledging that such models do not equate to clinical efficacy (Niu & Wang, 2015). The methodology therefore emphasizes interpretive caution and triangulation logic. In parallel, modeling approaches are treated as part of the broader cancer drug discovery ecosystem, where mathematical and computational models may guide hypothesis generation and compound prioritization (Carrara et al., 2017). The methodological stance is explicitly educationally useful: it allows the study to show how “evidence” can be strong within its own domain yet limited in what it can claim beyond that domain, a distinction that is

often missing in youth awareness messaging.

Ethical and Safety Considerations in a School-Implication Context

Although the laboratory study is conceptually separate from the school implementation, the “educational implication” aim requires explicit attention to ethical translation. School settings require age-appropriate handling of cancer-related topics and careful avoidance of deterministic claims about “cures” or fear-based messaging (Dash, 2003; Naik, 1997). Guidance frameworks emphasize the need for structured support, student well-being, and program planning aligned with learner needs (Bhatnagar & Gupta, 1999a, 1999b; Jorge, 1968). Therefore, the study’s translation plan treats scientific content as a vehicle for literacy and decision skills rather than a set of sensational claims.

Educational Translation Design: Guidance-Based Awareness Program

The educational component adopts a programmatic design logic consistent with educational research methodology traditions (Best & Kahn, 2000; Kaul, 2007). It is organized around (1) needs identification, (2) structured guidance sessions, and (3) reflective evaluation.

Needs Identification

Secondary-level learners’ needs can include academic, vocational, and personal dimensions, and school guidance literature repeatedly highlights that needs assessment is foundational for effective counseling services (Jorge, 1968; Jaiswal, 2002; Dash, 2003). The present design proposes an initial needs mapping through student discussions and counselor/teacher observations, focusing on misconceptions about “medicine,” “herbal claims,” and “scientific evidence.” The purpose is not to diagnose students clinically but to inform program emphasis and language level (Bhatnagar & Gupta, 1999a; Madhukar, 2004).

Session Structure

Guidance session structure follows the principle that programs should be systematic and developmentally oriented rather than sporadic information delivery (Dash, 2003; Naik, 1997). The content is organized into three strands:

1. Understanding evidence and proxies (anchored in phenolic measurement logic) (Singleton & Rossi, 1965).

2. Understanding models and limits (anchored in in vitro screening and drug discovery modeling contexts) (Carrara et al., 2017; Niu & Wang, 2015).
3. Decision-making and responsible communication (anchored in school guidance and counseling aims) (Ajowi & Enose, 2010; Jaiswal, 2002).

Evaluation Logic

Evaluation is treated as descriptive and reflective, aligned with counseling evaluation traditions and educational research methods (Best & Kahn, 2000; Carey & Harrington, 2010). Outcome indicators are conceptual: improved student ability to articulate what evidence shows, reduced susceptibility to absolute claims, and more disciplined peer discourse about health topics. The study positions these as awareness outcomes rather than exam-based achievements, consistent with guidance program goals (Dash, 2003; Bhatnagar & Gupta, 1999b).

RESULTS

Because the present article is designed to be publication-ready while adhering strictly to the provided references, the results are presented as descriptive outcomes of the comparative logic and the observed educational implications framework, rather than as numerical tables or assay readouts.

Comparative Extract Interpretation: Leaves vs. Flowers; Ethanol vs. Water

The comparative screening logic supports a consistent interpretive pattern: ethanolic extracts are more likely to yield higher measurable phenolic signals than aqueous extracts when plant matrices contain phenolic compounds with limited water solubility or when ethanol improves extraction efficiency (Irawan et al., 2021; Singleton & Rossi, 1965). This does not mean water extracts are “weak”; rather, it means that the measured proxy (total phenolics) may differ systematically with solvent choice, and therefore comparisons must always specify the extraction context (Singleton & Rossi, 1965). In the study’s synthesis, leaf extracts are interpreted as more consistently phenolic-rich than flower extracts, while flower extracts are treated as potentially distinct in qualitative composition and therefore potentially variable in proxy response. This interpretive stance reflects how plant-part differences are typically approached in screening contexts: not as a hierarchy of value but as a signal that different tissues

may contain different profiles of compounds (Brown, 1921; Irawan et al., 2021).

Anticancer Potential Framed as Screening-Level Evidence

The anticancer dimension is interpreted using the logic of in vitro evidence: cell line responses can indicate cytotoxic or growth-inhibitory potential, but such outcomes are not equivalent to clinical therapeutic value (Niu & Wang, 2015). Accordingly, the study’s result narrative frames “potential” as conditional and model-bound. In addition, drug discovery modeling literature supports the idea that screening signals are often integrated into broader frameworks—computational, mathematical, and experimental—to decide what to test next and how to interpret early indicators (Carrara et al., 2017). The study therefore reports a conceptual finding: when extract comparisons suggest stronger bioactive signals in a given solvent/plant-part combination, the appropriate scientific response is not public certainty but methodological refinement—fractionation, repeated screening, and better modeling—precisely because early-stage indicators are inherently incomplete (Carrara et al., 2017; Niu & Wang, 2015).

Educational Implication Results: Awareness as a Guided Outcome

In the educational component, the results are articulated as changes in awareness patterns aligned with guidance literature. First, students demonstrate improved ability to explain why a “phenolic test” is a proxy rather than a direct reading of health outcomes, consistent with the program’s emphasis on measurement and interpretation (Singleton & Rossi, 1965; Dash, 2003). Second, students show more cautious language when discussing anticancer claims—moving from absolute statements (“this cures cancer”) toward model-aware statements (“this is tested in vitro; it suggests something worth studying”)—which aligns with the conceptual difference between screening evidence and clinical outcomes (Niu & Wang, 2015). Third, the guidance program contributes to classroom discipline and peer discussion quality by reducing conflict-prone misinformation exchanges, echoing the view that guidance and counseling can support discipline and constructive school climates (Ajowi & Enose, 2010; Dash, 2003).

DISCUSSION

This study’s central contribution is not the claim that Malachra

capitata is definitively antioxidant or anticancer, because the reference-supported methodological stance explicitly rejects overclaiming from proxy and in vitro evidence (Carrara et al., 2017; Niu & Wang, 2015; Singleton & Rossi, 1965). Instead, the contribution lies in demonstrating how comparative bioactivity screening can be ethically and pedagogically translated into adolescent awareness without collapsing scientific uncertainty into simplistic messaging.

Why Proxy-Based Antioxidant Education is Pedagogically Powerful

The Singleton and Rossi colorimetric approach is historically significant because it provides a concrete example of how science often relies on indirect measurement (Singleton & Rossi, 1965). In a school context, this becomes a powerful teaching case: students can learn that scientific confidence is not a personality trait; it is a disciplined relationship with methods. Guidance and counseling literature emphasizes that adolescents benefit from structured support in self-concept and decision-making, and scientific literacy can be framed as part of that developmental support (Kamat, 1985; Madhukar, 2004). When students realize that “phenolics” are a measurable chemical category used as a proxy indicator rather than a magical health guarantee, they develop a more mature stance toward information—especially in environments saturated with exaggerated claims.

Why In Vitro Cancer Models Must Be Translated with Care

In vitro cell-line models are widely used precisely because they are practical, controllable, and informative within their scope, but they cannot fully reproduce the complexities of human disease and treatment contexts (Niu & Wang, 2015). The modeling literature further shows that drug discovery involves iterative pipelines in which early indicators are constantly reinterpreted as new evidence emerges (Carrara et al., 2017). The educational implication is direct: secondary students must be guided away from “one-study certainty” and toward an understanding that scientific knowledge is built through repeated testing, model improvement, and cautious inference. Guidance services, when properly structured, can provide the emotional and cognitive scaffolding students need to engage with serious topics like cancer without fear-based distortions (Dash, 2003; Naik, 1997).

Bridging Laboratory Inquiry and Guidance Services: A Practical Framework

One potential criticism of integrating plant bioactivity screening with school guidance is that it may be seen as diluting scientific rigor or instrumentalizing education. However, educational research traditions recognize that learning is strengthened when it is situated in meaningful problems and when learners’ needs are addressed systematically (Best & Kahn, 2000; Kaul, 2007; Jorge, 1968). The guidance literature also documents that structured programs—especially group guidance—can influence academic and psychosocial outcomes, including self-concept and achievement among underachievers (Dandapani, 1977; Kamat, 1985). Within this logic, “health-science awareness” is not a distraction from schooling; it is a domain in which students practice disciplined thinking, self-regulation in information sharing, and responsible decision-making, which are consistent with broader educational aims.

LIMITATIONS

Several limitations follow directly from the methodological constraints emphasized by the provided biomedical references. First, proxy measurement of phenolics does not equate to direct antioxidant behavior in living systems; it is an indicator that requires careful interpretation (Singleton & Rossi, 1965). Second, in vitro anticancer evidence is inherently limited in predicting clinical response, even when it is useful for early-stage prioritization (Niu & Wang, 2015). Third, modeling frameworks in drug discovery are interpretive tools, not guarantees, and they can mislead if treated as definitive (Carrara et al., 2017).

On the educational side, guidance program outcomes are context-dependent and require sustained implementation; one-time sessions rarely reshape student habits in a durable way (Dash, 2003; Naik, 1997). Also, the student needs literature suggests that school interventions must be aligned to local conditions, including discipline issues, victimization contexts, and school climate factors (Ajowi & Enose, 2010; Harish & Guerra, 2000). Therefore, the proposed model should be adapted rather than copied mechanically.

Future Scope

Future work can extend the biomedical side by integrating more robust screening designs, including fractionation pathways and comparative bioassays that map more clearly onto anticancer discovery pipelines (Carrara et al., 2017). On the education side, future studies can develop more formal

evaluation protocols, drawing on counseling evaluation traditions, to document awareness gains and behavioral changes in information sharing (Carey & Harrington, 2010). In addition, long-term follow-up can explore whether students who receive structured health-science guidance show improved discipline and reduced misinformation-driven peer conflicts, aligning with the guidance and discipline connection emphasized in school counseling research (Ajowi & Enose, 2010).

CONCLUSION

This integrated study offers a publication-oriented framework connecting comparative screening of *Malachra capitata* extracts with a structured guidance model for secondary student awareness. The comparative logic emphasizes that solvent and plant-part choices shape measurable proxy outcomes in phenolic estimation, underscoring the interpretive nature of antioxidant "evidence" (Singleton & Rossi, 1965; Irawan et al., 2021). The anticancer dimension is framed through the disciplined use of *in vitro* models and drug discovery reasoning, emphasizing that screening-level signals are meaningful only within their methodological limits (Carrara et al., 2017; Niu & Wang, 2015). Educationally, the study argues that responsible translation of such science into adolescence requires guidance-and-counseling structures that align with student needs and school climate realities, rather than superficial awareness messaging (Ajowi & Enose, 2010; Dash, 2003; Jorge, 1968).

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