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Science

Social vulnerability and environmental cancer risk in Louisiana: a cross-sectional analysis of incidence and airborne environmental exposures

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Abstract: Cancer incidence is shaped by environmental exposures and socioeconomic factors, such as poverty, minority status, and limited access to resources. In Louisiana, these risks are exacerbated by the proximity of vulnerable communities to industrial facilities known for toxic emissions. This cross-sectional study used correlation analysis and linear regression models to analyze public datasets to examine the relationships among cancer incidence, point source cancer risk, and key Social Vulnerability Index (SVI) factors. Populations residing near industrial facilities experienced higher point source cancer risk, with demographic patterns: racial and ethnic minority communities, as well as low-income populations, have a disproportionate burden of exposure, indicating geographic concentration of exposure. Combined effects of point source risk, crowding, and no vehicle access also increased cancer incidence. These findings highlight the urgent need for policy reforms, community-based interventions, and enhanced environmental monitoring to reduce cancer disparities in vulnerable Louisiana populations. Targeted health initiatives and updated exposure assessments are also essential to support equitable cancer prevention in Louisiana's high-risk communities.

Keywords: Air toxins, Cancer incidence, Environmental hazards, Louisiana, Social vulnerability.

Introduction

Louisiana is one of the most industrialized states in the United States, boasting numerous refineries and petrochemical manufacturing facilities, with hundreds of these facilities distributed throughout the state (Juhasz, 2024). However, these facilities are mostly aggregated in areas such as Calcasieu Parish in the southwestern portion of the state and in an 85-mile stretch of land situated between Baton Rouge and New Orleans in the southeast, which is colloquially referred to as “Cancer Alley” (Bakshi et al., 2022; Juhasz, 2024). Residents living in the communities surrounding these areas, known as fence-line communities, are exposed to constant pollution from toxic air pollutants released by these facilities (Fos et al., 2021; Juhasz, 2024). Environmental health disparities exist throughout various regions of the United States (Jbaily et al., 2022). However, a large portion of Louisiana is exposed to an extremely disproportionate burden of disease due to environmental exposures, particularly in communities near industrial corridors like Cancer Alley, which face compounding structural and infrastructural disadvantages (Fos et al., 2021; Terrell & St Julien, 2022a). Cancer remains a leading cause of death in Louisiana, further exacerbating public health disparities across vulnerable populations (Terrell & St Julien, 2022a; Callison et al., 2022).

Point source cancer risk refers to the potential health threat caused by exposure to carcinogenic air pollutants emitted from fixed, identifiable sources such as industrial facilities, refineries, and manufacturing plants (Madrigal et al., 2024). The United States possesses some of the strictest regulatory laws regarding fossil fuels, but enforcement of these laws is critically insufficient (Juhasz, 2024). According to the U.S. Environmental Protection Agency (U.S. EPA)’s 2019 Toxics Release Inventory and Risk-Screening Environmental Indicators (RSEI) model, Louisiana has released more pounds of industrial toxic air pollution than any other state (U.S. EPA, 2022; Terrell & St Julien, 2022b). The U.S. EPA continues to comprehensively screen and evaluate the emission of pollutants throughout the country using the National-Scale Air Toxics Assessment (NATA; U.S. EPA, 2025). The NATA provides estimates of the risk of cancer and other serious health effects from inhaling air toxics to inform both national and localized efforts to identify and prioritize air toxics, emission source types, and locations that are of greatest potential concern in terms of contributing to population risk (U.S. EPA, 2015).

Social vulnerability refers to demographic and socioeconomic factors, such as poverty, limited access to transportation, and overcrowded housing, that adversely affect communities that encounter hazards and other community-level stressors (Cimino et al., 2020; Decker et al., 2024). The *Social Vulnerability Index* (SVI) is a place-based index,

database, and mapping application designed to identify and quantify communities experiencing social vulnerability (CDC/ATSDR, 2024). The health impacts of air pollution vary across regions, often depending on proximity to emission sources and the availability of healthcare, transportation, and housing infrastructure (Woodruff et al., 2003; Tessum et al., 2019; Colmer et al., 2020). Exposure to pollutants emitted from these facilities is known to contribute to various health conditions, including cancer and respiratory diseases (Ajayi & Ogunjobi, 2024; Lo et al., 2024). Contemporary research has also shown that social vulnerabilities play a significant role in the progression of these conditions. Lack of access to healthcare, poverty, low educational attainment, and minority status are just a few examples of factors that disproportionately affect residents in fence-line communities (Mikati et al., 2018; Colmer et al., 2020; Ard & Smiley, 2021).

The unequal exposure to environmental hazards in specific locations has recently become a focus for policymakers and researchers (NAACP LDF, Inc., 2021; Fos et al., 2021). However, few studies have examined the interaction between social vulnerability and exposure to air toxins, or how the interaction may impact an individual's risk of developing adverse health conditions (Chakraborty, 2022). Building upon our previous spatial analysis (Smith et al., 2025), we investigated how social and environmental factors correlate with cancer incidence in Louisiana. To study this, publicly available datasets were utilized to identify disparities across Louisiana. This study aims to understand how integrating environmental exposure data with demographic and social indicators such as income levels, education, race/ethnicity, and housing conditions reveals disparities in cancer risk and incidence linked to environmental injustices.

Methods

Study design

This study employs a cross-sectional design to investigate the relationship between cancer incidence, point source cancer risk, and social vulnerability at the parish level across Louisiana. Data sources utilized in the analysis are summarized in Table 1. All datasets were aggregated at the parish level. Data collected between 2011 and 2020 from 63 of Louisiana's 64 parishes were included; Tensas Parish was excluded due to missing cancer incidence data from the Louisiana Tumor Registry (LTR; Maniscalco et al., 2024). The selection of SVI indicators was based on literature identifying transportation, minority status, and housing conditions as key contributors to health vulnerability. Specifically, 'no vehicle access' and 'crowding' were prioritized due to their established association with limited access to healthcare services and increased risk of environmental exposure. These factors

have been repeatedly cited in public health literature as indicators of structural disadvantage that amplify disease burden in underserved populations.

It is essential to note that the U.S. EPA's point source cancer risk data are from 2011 (U.S. EPA, 2025), whereas the cancer incidence data span the period from 2011 to 2020. This temporal mismatch limits causal inference and may affect alignment between exposure and disease outcomes.

Table 1

Data sources with references

Variable	Data source	Definition	Reference
Cancer incidence	Louisiana Tumor Registry (LTR), 2011-2020 Data Years	The number of newly diagnosed cancer cases in a specified population during the specified years, expressed as the number of cancers per 100,000 people.	(Maniscalco et al., 2024)
Point source cancer risk	National Air Toxics Assessment (NATA), 2011 Data Year	Pollution that comes from a single, identifiable source, such as a pipe, a ditch, or a factory smokestack.	(U.S. EPA, 2025)
Social vulnerability	Social Vulnerability Index (SVI), 2022 Data Year	The demographic and socioeconomic factors (such as poverty, lack of access to transportation, and crowded housing) that adversely affect communities that encounter hazards and other community-level stressors.	(CDC/ATSDR, 2024)

Statistical analysis

SPSS Statistics v. 26 (IBM, Inc., 2019) was utilized to conduct correlation, regression, and interaction analyses. Before performing the analysis, exploratory data analysis (EDA) was conducted to gain a better understanding of the distributions and potential issues within the data. The primary steps of the EDA included examining skewness, kurtosis, box plots, and histograms.

To meet the assumptions of linear regression and enhance the model's fitness, a log base 10 transformation was applied to the point source cancer risk. For simplicity, the transformed point source cancer risk is referred to as 'Tr point source cancer risk'. Following the transformation, the normality of residuals and homoscedasticity were re-evaluated using diagnostic plots. The linear regression assumptions were subsequently verified and found to be adequately satisfied. Multicollinearity among predictor variables was also assessed, with no evidence of extreme correlations observed. In the regression analysis, cancer incidence was the dependent variable and point source cancer risk and social vulnerability indicators such as income level, educational attainment, and minority status were the independent variables.

Interaction terms were selected a priori based on theoretical frameworks and prior studies suggesting that combined effects of environmental exposures and social vulnerability, such as limited mobility or overcrowded living conditions, can amplify cancer risk beyond the impact of individual factors alone (Smith et al., 2025).

A hotspot analysis was conducted on point source cancer risk in ArcGIS Pro 3.4 (Esri, Inc., 2024). This spatial analysis helped to identify and evaluate statistically significant spatial and geographic clusters. The K closest point sources are identified as the neighborhoods for each target source. This method offers a consistent and reasonably reliable spatial neighborhood definition, particularly for regions that have varying densities of point source cancer risks, ensuring that each source is analyzed in relation to a minimum number of nearby sources, even in areas where there are fewer point sources.

Results

Descriptive statistics

Table 2 presents the descriptive statistics for key variables used in the study across 63 parishes in Louisiana. The average cancer incidence rate was 484.19 cases per 100,000 population ($SD = 27.41$). The estimated point source cancer risk varied widely, with values ranging between 0.025 to 225.22 and a mean of 5.60 cases per million ($SD = 28.39$). This

wide range highlights the disproportionate impact of localized air pollution, particularly in parishes with a high concentration of petrochemical facilities, which significantly contributes to elevated point source cancer risk. These findings suggest that environmental exposure, industrial activity, and population vulnerability were not uniform throughout Louisiana. Figure 5 (Appendix B) illustrates the distribution of cancer incidence and point source cancer risk in Louisiana.

Table 2. Descriptive statistics

Variable	Nature of variable	<i>N</i>	Min.	Mean	Max.	<i>SD</i>
Cancer incidence	Continuous	63	41.53	484.19	531.91	27.41
point source cancer risk	Continuous	63	0.025	5.60	225.22	28.39
Tr point source cancer risk	Continuous	63	8.40	9.89	12.35	0.68

Correlation Analysis

The correlation analysis revealed a weak but statistically significant positive association between racial and ethnic minority status and point source cancer risk ($r = 0.26$, $P = 0.03$), indicating that communities with higher proportions of racial and ethnic minorities tend to experience greater exposure to environmental hazards. As shown in Figure 2 (Appendix A), these associations are spatially concentrated in industrial corridors, such as Cancer Alley. Research has shown that in Louisiana, many industrial facilities are often located adjacent to predominantly Black neighborhoods (Terrell & St Julien, 2022a). These findings highlight patterns of environmental risk clustering in socially vulnerable areas, underscoring the role of structural and geographic inequities in shaping cancer risk exposure.

Multivariate Linear Regression

Multivariate regression analysis between Cancer incidence and SVI factors.

The multivariate regression analysis revealed a significant positive relationship between lack of vehicle access and cancer incidence, with a regression coefficient of 48.71 ($P = .002$; see Table 3). This suggests that communities with limited transportation resources may experience higher cancer incidence rates, potentially due to reduced access to healthcare, preventive services, and timely medical interventions. As illustrated in Figure 1 (Appendix

A), a clear upward trend in cancer incidence is observed in parishes with higher proportions of households without vehicles.

A negative relationship was identified between cancer incidence and poverty, likely due to limited access to preventive healthcare services in these populations, which can result in cancers going undetected or diagnosed at later stages.

Table 3. Linear regression analysis between Cancer incidence and no vehicle access

Variable	Coefficient	Std. Error	<i>t</i>	<i>P</i>	95% CI
C	503.69	10.29	48.97	0.00	483.10 - 524.28
no vehicle access	48.71	14.63	3.33	0.002	19.41 - 77.99

Adjusted R^2 : 0.18

Multivariate regression analysis between point source cancer risk and SVI factors.

Table 4 illustrates the positive relationships identified in the multivariate regression analysis. The multivariate regression model indicates that racial and ethnic minority status was positively correlated with point source cancer risk ($\beta = 1.28$, $P < 0.001$, 95% CI: 0.81–1.74), explaining 55% of the variance (Adjusted $R^2 = 0.55$).

Table 4. Linear regression analysis between Tr point source cancer risk and the racial and ethnic minority status

Variable	Coefficient	Std. Error	<i>t</i>	<i>P</i>	95% CI
C	10.873	0.23	51.55	0	10.45 - 11.29
minority status	1.28	0.23	5.55	0.00	0.81 - 1.74

Adjusted R^2 : 0.55

As shown in Figure 2 (Appendix A), a higher minority status is correlated with increased pollution exposure in southeastern parishes. The findings from Callison et al. (2021) and Terrell and St. Julien (2022a) highlight that social vulnerability factors, especially racial and ethnic minority status, significantly influence exposure to environmental cancer risks. Black

populations are disproportionately located near industrial facilities, increasing their risk of exposure to harmful pollutants. This underscores the urgent need for targeted public health interventions and policy strategies to address these disparities.

Multivariate regression analysis between interaction terms (Tr point source cancer risk with SVI) and cancer incidence.

Table 5 summarizes the positive relationships identified in the analysis. The interaction analysis revealed that the combined effect of point source cancer risk and two key social vulnerability indicators, crowding and lack of vehicle access, significantly contributed to increased cancer incidence. Specifically, the interaction between point source cancer risk and crowding was statistically significant, with a regression coefficient of 2.45 ($P = 0.03$). This indicates that crowded living conditions in marginalized communities, which are often located near industrial facilities or high-emission zones, increase cancer incidence due to heightened exposure to environmental pollutants.

Furthermore, the interaction between point source cancer risk and no vehicle access demonstrated an even stronger association. Individuals without vehicle access may experience greater isolation and mobility limitations, which can hinder their ability to avoid polluted areas and access timely medical care. Figures 3 and 4 (Appendix A) illustrate these relationships through scatterplots, revealing two key trends: firstly, the combination of higher environmental cancer risk and crowded living conditions appears to be associated with a marginal increase in cancer incidence. Secondly, as the interaction between environmental cancer risk and limited vehicle access increases, cancer incidence tends to rise slightly.

Table 5. Linear regression analysis between interaction terms (Tr point source cancer risk with SVI factors) and Cancer incidence

Variable	Coefficient	Std. Error	<i>t</i>	<i>P</i>	95% CI
C	495.66	11.16	44.42	0.00	473.31 - 518
Tr point source cancer risk*crowding	2.45	1.12	2.11	0.03	0.12 - 4.77
Tr point source cancer risk*no vehicle	5.1	1.47	3.46	0.00	2.15 - 8.04
Adjusted R^2 : 0.21					

Hotspot analysis

Figure 6 (Appendix B) illustrates the hotspot analysis of point source cancer risk, which identifies statistically significant spatial clusters. This approach enables a more effective identification of risk assessment and management strategies for higher-vulnerability geographic areas. The red shaded areas indicate that statistically significant hotspots of higher cancer risk are concentrated in the southeastern part of the state, an area where industrial facilities are densely populated. Analysis employing the K-nearest neighbors also supplied better estimates of spatial clustering, which supported the results. Figure 7 (Appendix B) also highlights regions with elevated cancer incidence rates with higher point source cancer risk; zones with the highest confidence ratings are located in the southeastern region of the state.

1.1.1 Discussion

This study highlights the interaction among environmental risk factors, social vulnerability indicators, and cancer incidence in Louisiana, a state with one of the highest concentrations of industrial facilities in the United States. These findings expand upon Smith et al.'s (2025) prior spatial analysis of cancer risk and social vulnerability in Louisiana, which demonstrated regional disparities in cancer outcomes driven by environmental exposure and social factors.

Overall, the study found a significant and positive association between racial and ethnic minority status and point source cancer risk ($\beta = 1.28$, $P < 0.001$). Notably, Zavala et al. (2020) highlighted systemic disparities in environmental exposures, such as proximity to industrial pollution sources, as a key driver of elevated cancer risk among racial and ethnic minorities. Similarly, Terrell and St Julien (2022b) found significantly higher pollution-related cancer risks in predominantly Black and low-income communities between Baton Rouge and New Orleans. These results are consistent with national studies, demonstrating that Louisiana ranks among the top five U.S. states for both industrial air pollution and cancer mortality (Juhasz, 2024; CDC, 2024).

Transportation is an important yet often overlooked element in the delivery of high-quality and accessible cancer care. The multivariate regression analysis, along with interaction terms, revealed no vehicle access as a significant positive predictor. This finding is consistent with research by Graboyes et al. (2022), which found that transportation barriers prevent many patients with cancer from accessing timely and effective care. Additionally, these results align with research conducted by Larsen, Rydz, and Peters (2023), indicating that exposure to hazardous air pollutants tends to be more pronounced in areas characterized by limited access to infrastructure and essential services.

A negative relationship was found between cancer incidence and poverty ($\beta < -31.9$, $P = 0.04$). One potential explanation is underdiagnosis in low-income populations due to reduced access to preventive care and screenings. This aligns with studies such as Caraballo et al. (2022), which found systemic barriers to timely medical care among disadvantaged groups. Alternatively, misclassification or data gaps in rural and underserved parishes may contribute to this unexpected finding.

Housing insecurity encompasses challenges such as high housing costs, frequent relocation, crowding issues, and homelessness. A study conducted by Fan et al. (2022) showed there was a strong connection between housing insecurity and negative cancer outcomes, reiterating the need to routinely identify housing needs in patients, including homelessness, crowding, and unsafe or unstable housing. Similarly, this study found that crowding, along with environmental cancer risk, predicts higher cancer incidence.

These findings underscore the need for targeted public health interventions in communities that bear the disproportionate burden of environmental pollution and social vulnerability. Politically, stricter emissions regulations are appropriate, particularly in areas like Cancer Alley. Stricter policies should include real-time air pollution monitoring to ensure compliance and allow regulators to manage excess emissions to reduce environmental impacts on vulnerable communities.

Limitations

While the findings contribute valuable insights, certain limitations must be considered. Key confounding variables, such as smoking, obesity, alcohol consumption, and other environmental exposures (e.g., water contamination, radiation, and occupational hazards), were not included in this analysis. Future research should consider all these factors in subsequent studies. Additionally, the use of parish-level data may miss more minute differences in the correlations.

The use of 2011 NATA data (U.S. EPA, 2025) may introduce a temporal mismatch with cancer incidence data from 2011-2020. More recent data may have a greater impact in this type of analysis. Additionally, using secondary data that was collected for a different purpose limits causal inference and may introduce bias due to a lack of control over data collection. The use of this cross-sectional study design does not allow for causal inferences to be made. Future studies should implement a longitudinal study design, which may further strengthen causal insights by capturing temporal changes in both exposure and health outcomes over time.

Conclusion

The findings of this study underscore the urgent need for targeted policy interventions to address environmental health disparities in Louisiana, particularly in high-risk areas such as Cancer Alley. The observed associations between cancer incidence, point source cancer risk, and social vulnerability highlight the importance of integrating public health and environmental justice efforts, as well as strengthening enforcement of the Clean Air Act to reduce harmful emissions from industrial sources that disproportionately impact vulnerable communities. Expanding mobile cancer screening programs and improving transportation infrastructure can enhance access to care in underserved regions. Beyond strengthening policy enforcement and emissions monitoring, it is essential to integrate community-based cancer screening initiatives into environmental response plans, especially in industrial zones. Community participatory research is also critical to building trust and capturing lived experiences, which can inform targeted interventions and drive effective policy reform.

Mandatory emissions monitoring in fence-line neighborhoods would improve transparency and accountability. Supporting localized assessments can improve understanding of health risks and guide more effective policy responses. Reducing geographic disparities in cancer outcomes requires improved distribution of healthcare resources, policy reforms, and integration of housing assessments into routine care. Investments in affordable, stable housing and public health infrastructure are critical to advancing health equity and reducing the burden of environmental cancer risk. To meaningfully reduce the burden of cancer, we must commit to a comprehensive approach that combines environmental accountability, equitable healthcare access, and housing stability.

Author contributions:

SSa: Conceptualization, Project administration, Methodology, Data curation, Data analysis, Writing. SSm: Writing- original draft, reviewing, and editing. CMG: Writing- original draft GMW: Conceptualization, Writing, reviewing, and editing.

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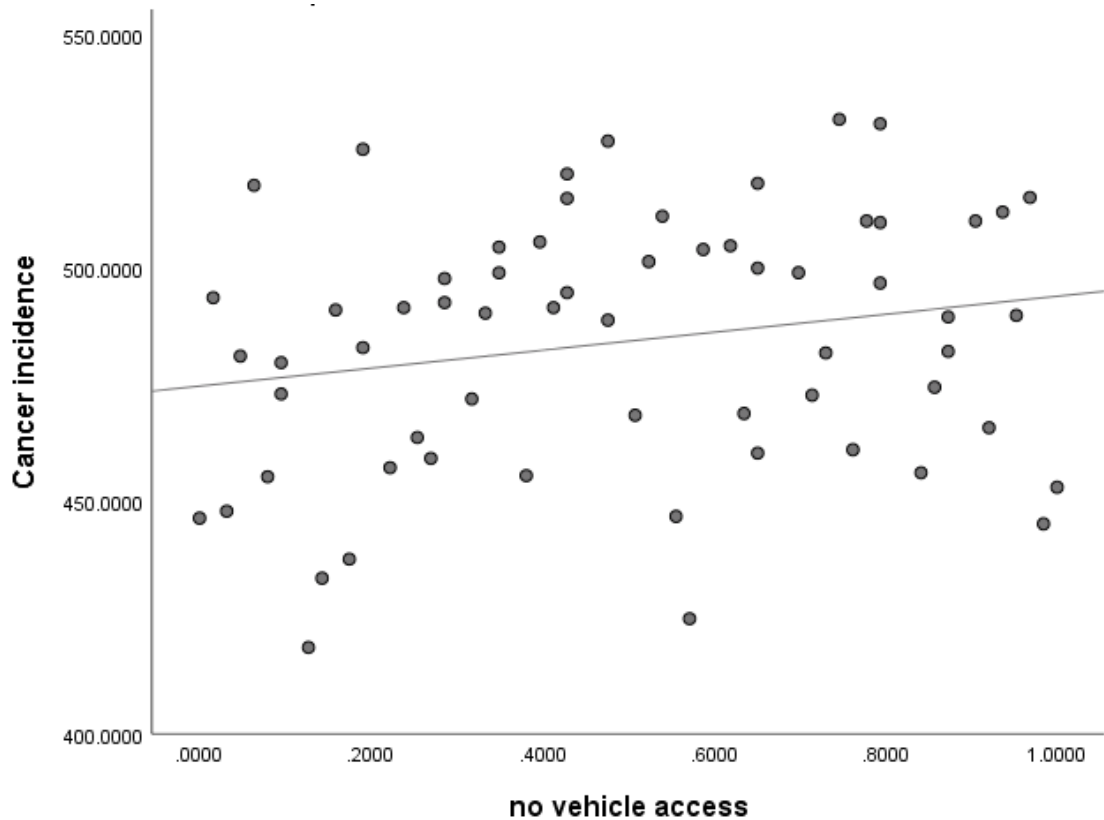
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Appendix A

Scatterplots

Figure 1

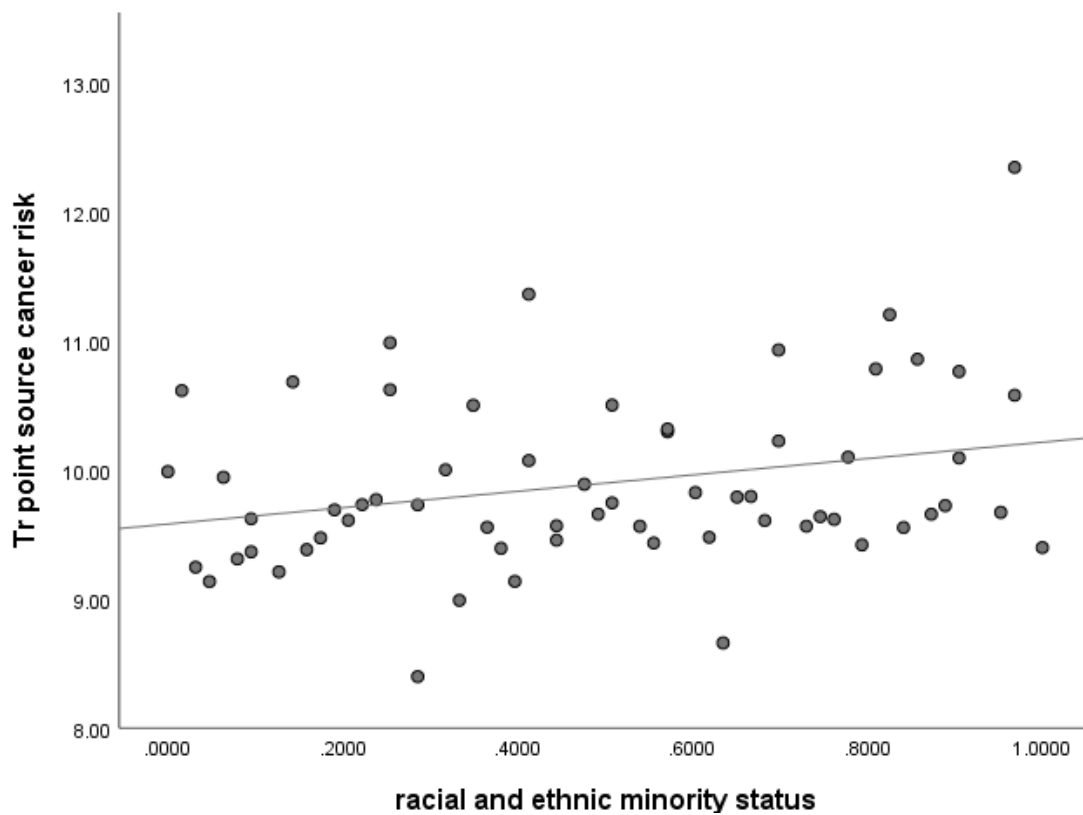
Simple scatter with a fit line of Cancer incidence and no vehicle access



Note. Scatterplot illustrating the positive relationship between cancer incidence and lack of vehicle access across Louisiana parishes. Parishes with higher proportions of households without vehicles exhibit higher cancer incidence rates.

Figure 2

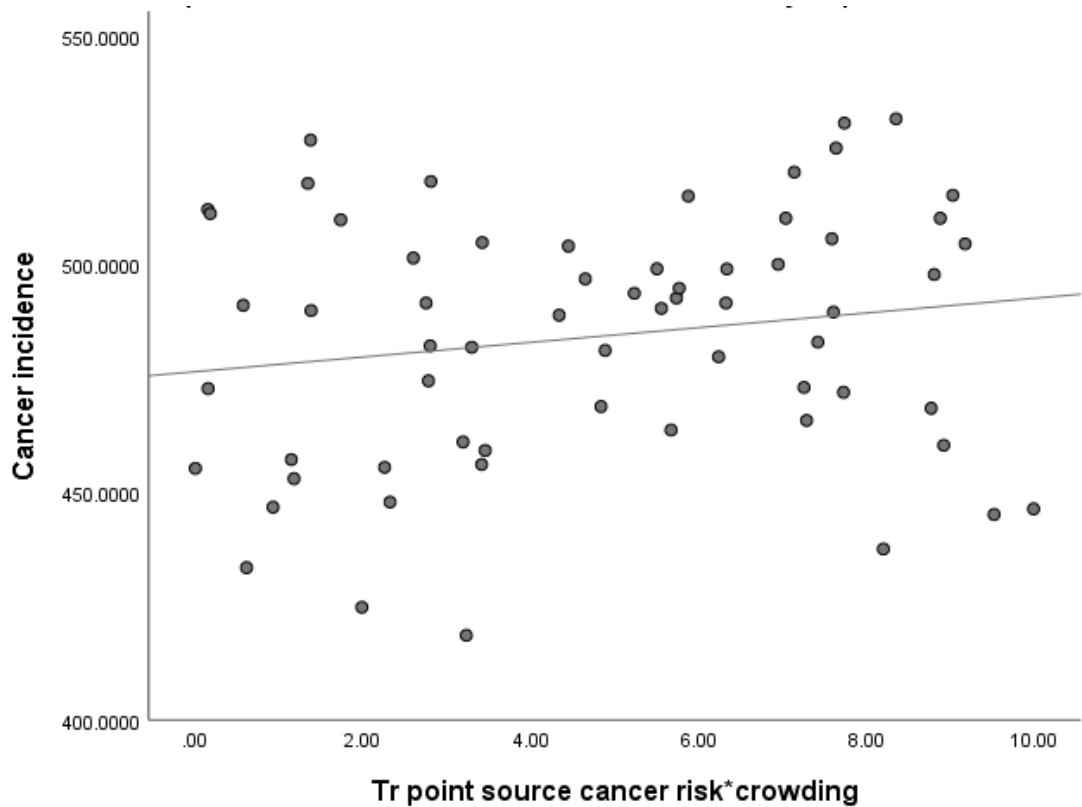
Simple scatter with fit line of Tr point source cancer risk and racial and ethnic minority status



Note. Scatterplot illustrating the positive relationship between log-transformed point source cancer risk and the proportion of racial and ethnic minority populations in each parish.

Figure 3

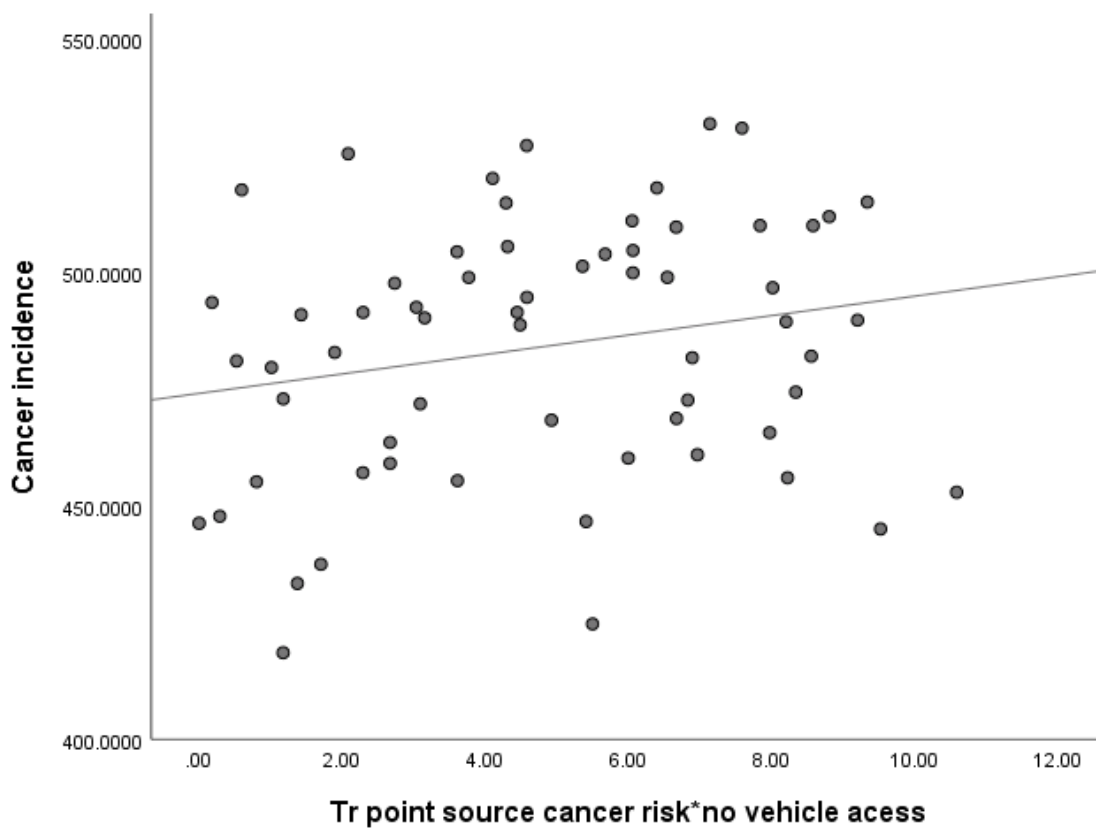
*Simple scatter with fit line of cancer incidence by Tr point source cancer risk*crowding*



Note. Scatterplot illustrating the interaction effect between point source cancer risk and household crowding on cancer incidence. Higher cancer incidence is observed in areas with higher population density and higher pollution levels.

Figure 4

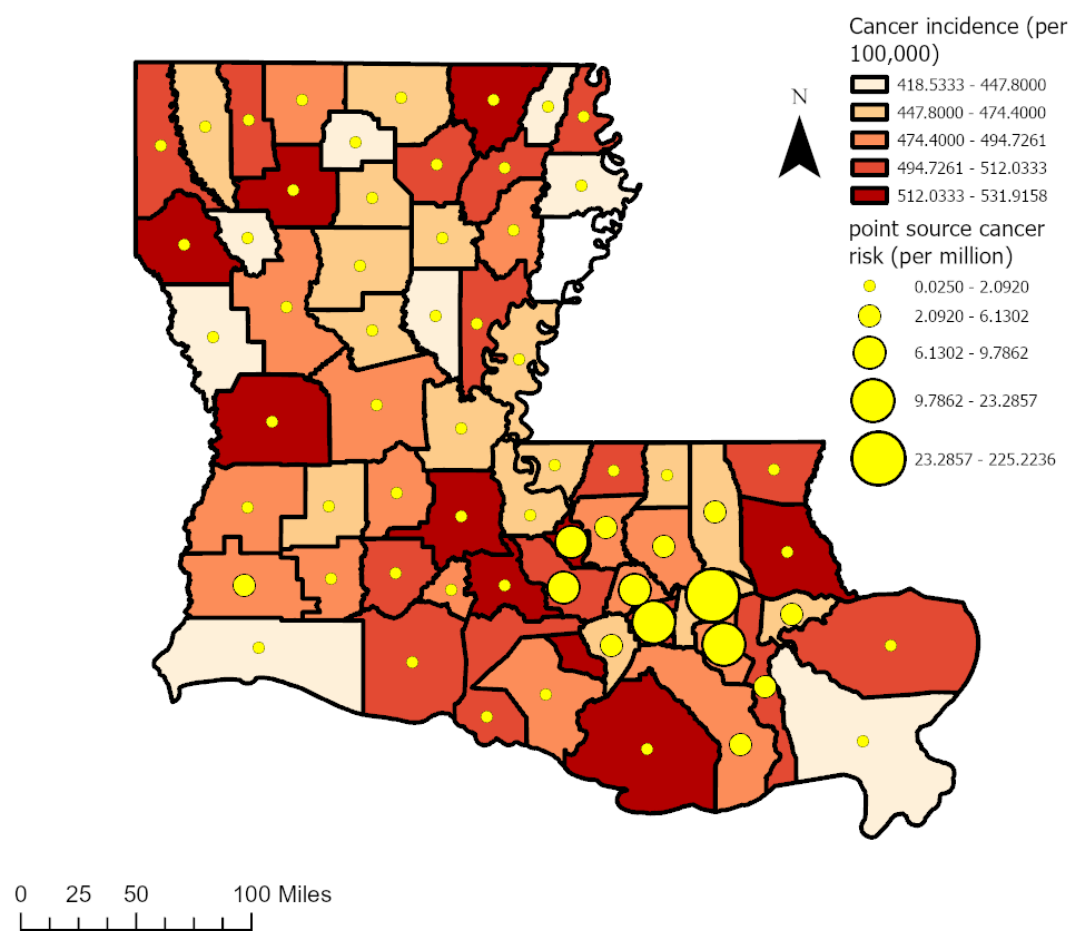
*Simple scatter with fit line of Cancer incidence by Tr point source cancer risk*no vehicle access*



Note. Scatterplot showing the interaction between point source cancer risk and lack of vehicle access. Cancer incidence increases significantly when both risk factors are present.

Appendix B
Maps

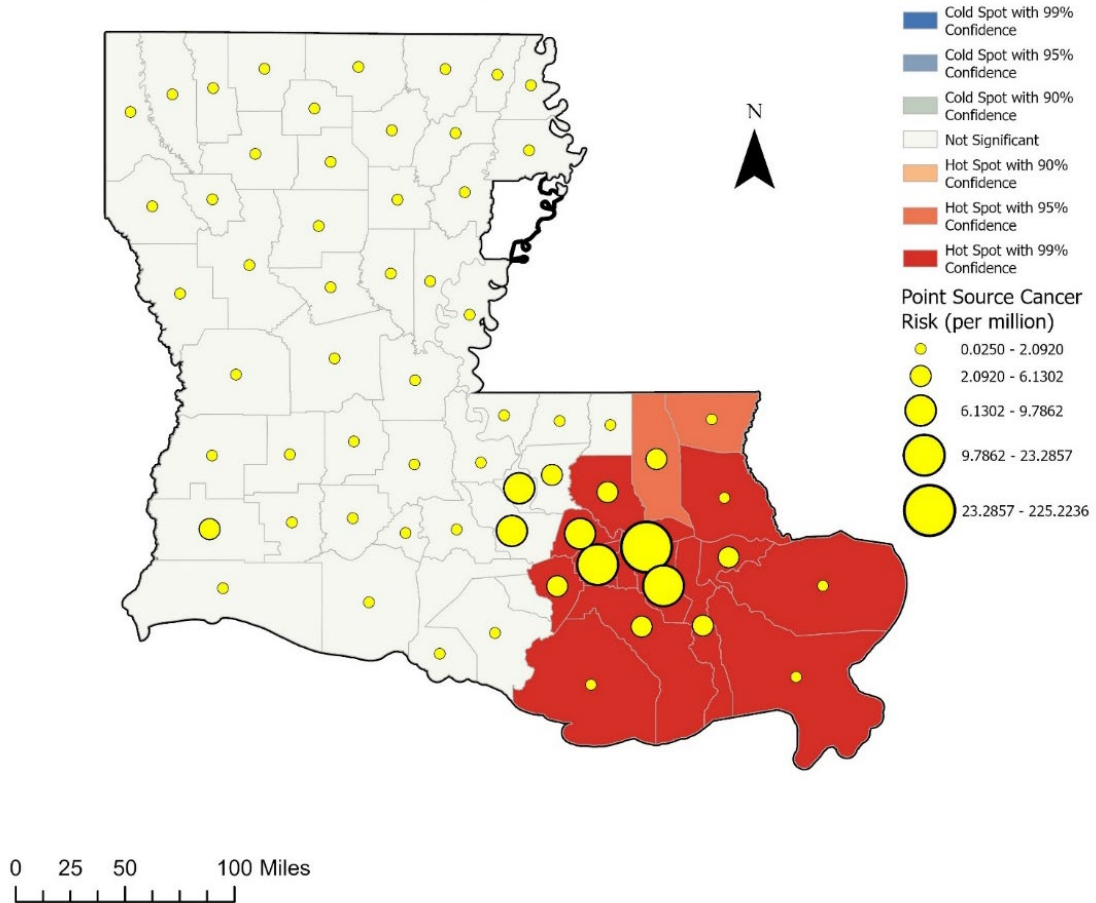
Figure 5
Cancer incidence and point source cancer risk



Note. Comparison of parish level cancer incidence and point source cancer risk across Louisiana. Visual differences illustrate spatial disparity in environmental exposures and health outcomes.

Figure 6

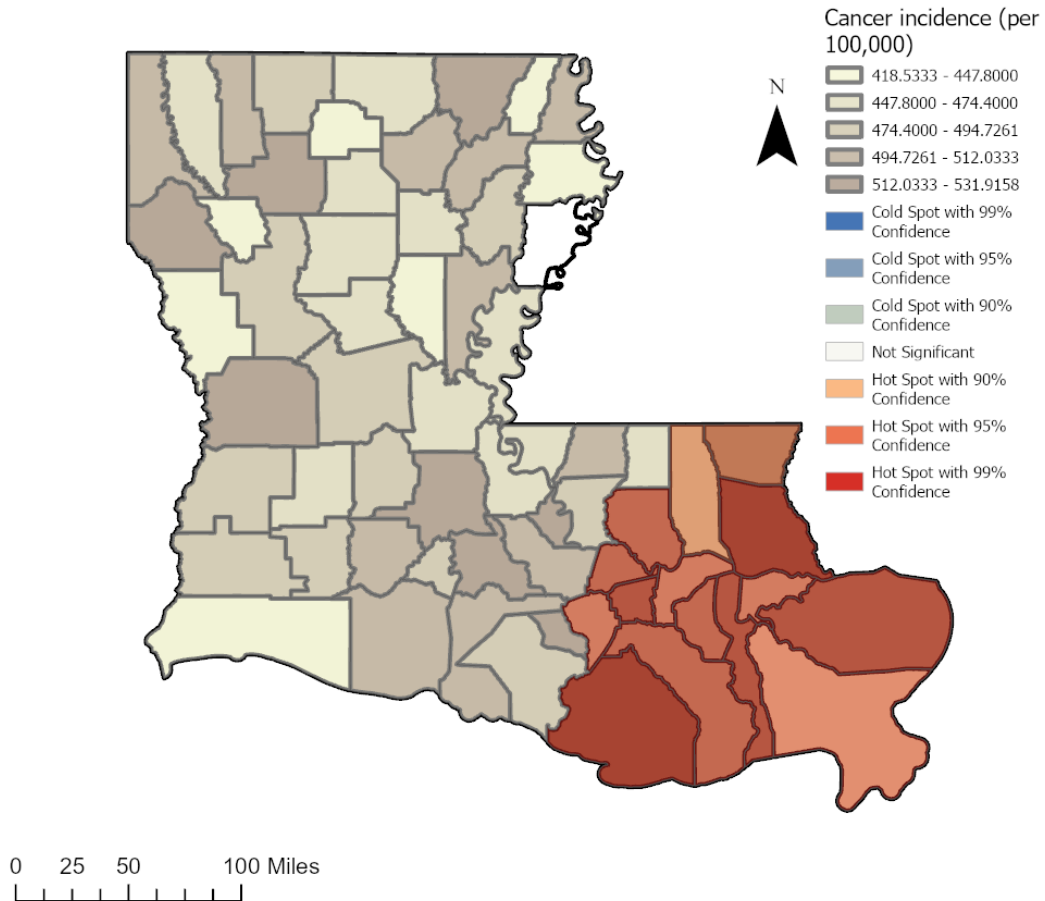
Hotspot analysis



Note. Hotspot analysis highlighting statistically significant clusters of elevated point source cancer risk, concentrated in southeastern Louisiana near industrial zones.

Figure 7

Cancer incidence and hotspots with higher point source cancer risk



Note. This hotspot analysis map highlights areas with elevated cancer incidence rates, particularly in the southeast, where clusters of hotspots show 95% and 99% confidence levels. These findings suggest a significant concentration of higher cancer incidence in these areas, potentially linked to environmental or point source factors.

Lupulone Delivered in Nanoparticles and the Promise to Defy Aging

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Abstract: This study reports synthesis and characterization of nanocomposite matrices (NP) designed to fight aging/photoaging of the skin. All materials used in the preparations were nontoxic, sustainable and beneficial to the skin. Zein (Z), from corn, is a moisture attractor. Lupulone (L) from hops is anti-inflammatory, antioxidant, antibacterial, stimulates circulation and collagen production, and has calming effect. Gum arabic (GA), from acacia trees, is used in foods as stabilizer/emulsifier. Chitosan (C), from chitin, is recommended by its properties: antioxidant, antibacterial, and filmogenic. A green procedure was used in the synthesis, replacing ethanol (typically used to dissolve Z/L) with 80:20 propylene glycol in water. The NP were characterized by FTIR, encapsulation efficiency of L, SEM, size and zeta potential. Antioxidant assays showed activity in all NP. They were assayed against MMP-1 (collagenase) as well. NP containing only Z and GA stimulated MMP-1 activity, which recommends them for use in wound healing. Those containing L too displayed inhibitory activity against MMP-1, stronger as L content increases. This anti-collagenase effect recommends them for use as anti-aging agents. Kinetic studies of L release from NP displayed levels too low for practical applications. To address this problem, in another set of preparations, C was added in the synthesis. The intent was to mitigate the strong lipophilic Z-L interactions. L release was positively impacted by C presence in the matrices. Increase due to C presence was afforded in antioxidant activity as well, although more modest than expected, since C is a known antioxidant. The anticollagenase activity was present and displayed the same variation as in the NP without C. The nanomatrices described are antioxidants, moisture attractors, and collagen synthesis stimulators which makes their promise to defy ageing very clear.

Keywords: chemistry, nanoparticles, zein, lupulone, antioxidant, collagen, MMP-1

(Title and abstract in Romanian)

Lupulona Încapsulată în Nanoparticule Promite Să Încetinească Îmbătrânirea

Rezumat: Acest studiu raportează sinteza și caracterizarea unor nanomatrice (NP) concepute să combată îmbătrânirea/fotoîmbătrânirea pielii. Toate materialele folosite în preparare sunt netoxice, naturale și folositoare pielii. Zeina (Z), din porumb, este hidratantă. Lupulona (L), din hamei, este antiinflamatoare, antioxidantă, antibacteriană, stimulează circulația și producția de collagen și are efect calmant. Guma arabică, din rășina pomilor acacia, este folosită în alimente ca stabilizator/emulsificator. Chitosanul (C), obținut din chitină, este antioxidant, antibacterian și filmogenic. Sinteza, eco-friendly, a înlocuit etanolul (folosit pentru dizolvarea Z/L) cu 80% propilenglicol în apă. NP au fost caracterizate prin FTIR, eficiența încapsulării pentru L, SEM, mărimea particulelor și potențial zeta. Toate NP au demonstrat efect antioxidant. Testate împotriva MMP-1 (colagenază), NP conținând numai Z and GA au stimulat activitatea enzimei, ceea ce le recomandă pentru tratarea rănilor. NP conținând și L au avut efect inhibitor, mai puternic la conținut ridicat de L. Efectul anticolagenază recomandă aceste NP pentru aplicații ca agenți anti-îmbătrânire. Fiindcă viteza eliberării L din NP nu a atins valori practice, un alt set de NP a fost preparat în care s-a adăugat C pentru a atenua interacțiunile lipofile Z-L. C a fost benefic pentru cinetica eliberării L și a contribuit la creșterea activității antioxidante a NP, dar nu la nivelul anticipat. Activitatea anti-colagenază a fost prezentă cu aceleași variații ca în setul de NP fără C. Proprietățile matricilor prezentate (efect hidratant, antioxidant, stimulator al sintezei collagenului) le recomandă ca agenți ce combat îmbătrânirea pielii.

Cuvinte cheie: chimie, nanoparticule, zeină, lupulonă, antioxidant, collagen, MMP-1

Skin care products which fight chronological aging and photoaging are of high interest in a time when the number of seniors is on the rise. Adding to this the effect prolonged exposure to UV radiation has (sunburn, inflammation, oxidative stress, photocarcinogenesis), such products have become of general interest. Ultraviolet radiation (all ranges) is particularly dangerous due to the potential to damage collagen in the extracellular matrix (ECM), which in some cases can lead to fully stopping collagen synthesis (Pandel et al., 2013). Topical applications used as protection are not very effective due to the barrier represented by the *stratum corneum* in the epidermis (Leonida & Kumar, 2016). Due to their size, nanomaterials have a strong penetration power into living tissues and, due to their large surface to volume ratio, allow use of lower doses for efficient treatment.

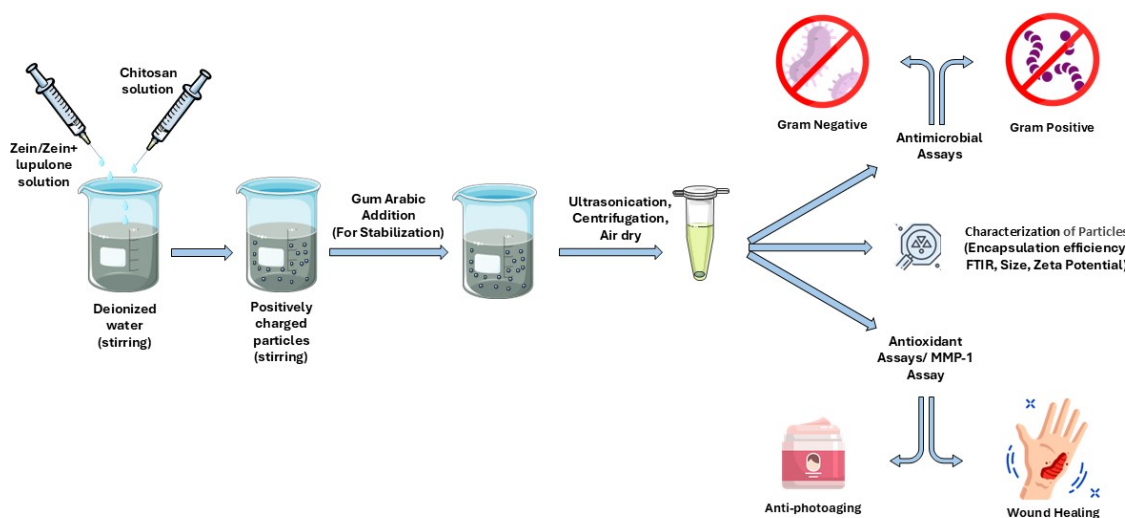


Figure 1. Preparation of composite matrices containing Z/L in different ratios (2:3 Z:GA in all preparations)

The present study reports the synthesis and characterization of nanocomposite matrices designed to address these concerns: chronological aging of skin, oxidation due to oxygen in the air, environmental agents, and bioavailability of bioactive agents. All materials used in the preparations were GRAS (generally regarded as safe) compounds obtained from natural sources. Zein (Z), a protein from corn rich in prolamin, is a powerful moisture attractor (Leonida et al., 2023). Lupulone (β -acid, L) from hops helps reduce inflammation, is antioxidant, antibacterial, stimulates circulation in the skin and collagen production, and has a calming effect (Natarajan et al., 2008). Gum arabic (GA), obtained from the sap of acacia trees, a mixture glycoproteins/ polysaccharide, is used in the food industry as stabilizer/emulsifier (Leonida et al., 2023). Chitosan (C) is an inexpensive biopolymer

obtained from chitin by deacetylation and is recommended by its filmogenic, antioxidant and antibacterial properties (Leonida et al., 2011). An environment-friendly, antisolvent procedure was used in the synthesis, which replaced the ethanol typically used to dissolve zein and lupulone with 80:20 propylene glycol in water. (Figure 1). Different Z:L ratios were used in the preparations.

FTIR spectra of the composites displayed the presence of all components and efficient L encapsulation. They evidenced the same type of complex interactions like those between zein and another lipophilic agent α -tocopherol in a matrix where GA was replaced by C (Luo et al., 2011), although the particles were larger in the present study (Table 1, adapted from (Leonida et al., 2023), with permission). The encapsulation efficiency (EE) increased as the ratio Z:L increased. The same trend was displayed when peppermint oil was encapsulated in zein-based nanomatrices (Luo et al., 2011) while higher EE values were reported for L encapsulated in a hydrophilic matrix (Leonida et al., 2018).

Table 1. Characterization of the composites containing different $Z_a:L_b$ ratios. Z:GA was 2:3 in all samples. Size and zeta potential values for nanoparticles suspended at 1 g/L in propylene glycol:water (80:20)

Sample	Encapsulation Efficiency (%)	Size (nm)	Zeta Potential (mV)
Z-GA	N/A	306	24.1
Z ₁ -GA-L ₁	29.2	467	11.2
Z ₂ -GA-L ₁	33.7	548	13.8
Z ₄ -GA-L ₁	60.3	909	12.8

When L content was low, it is likely that L molecules were deposited on the surface of zein nanoparticles, in addition of the migration into the lipophilic core, affording large size complexes. As L content increased, rearrangements were likely (for example outward migration) upon GA addition, which led to decrease in size. Luo *et al* (Luo et al., 2011) and Nagibzadeh *et al* (Naghibzadeh et al., 2010) reported the same trend for composites encapsulating lipophilic agents in polysaccharide-based nanomatrices. GA, negatively charged at pH 5, was used as stabilizer for the positively charged zein-based particles adding its emulsifying effect as additional stabilizer for the complexes. A sharp decrease in zeta

potential was recorded when neutral L was added, before complexation with GA. We relate this to conformational changes in Z (evidenced by FTIR spectra) due to hydrophobic interactions with L leading to decrease in the number of exposed positive charges. The positive zeta potential values are a good predictor of antibacterial activity of the discussed particles. Scanning electron microscopy (SEM) studies did not show morphological differences between nanocomposites with and without L.

Antioxidant assays showed activity in all composites (Figure 2). A remarkable finding was the antioxidant effect of the Z:GA nanoparticles, while none of the components is a known antioxidant. This observation is ascribed to the benefits of delivery at the nanolevel.

Collagenases, a type of metal metalloproteinases (MMP-1, MMP-8, MMP-13) degrade triple-helical collagen. In healthy tissues, endogenous inhibitors like tissue inhibitors of metalloproteinases (TIMPs) maintain homeostatic balance in their activities (Kumar et al., 2024). Under various pathological conditions, that balance is disrupted by either the over- or underexpression of MMPs or TIMPs. Skin exposure to UV radiation results in overexpression of MMPs (Gimeno et al., 2021) leading to degradation of the collagen and elastic fibers, including microfibrils in the skin. The result is skin sagging and wrinkle formation. MMPs play an essential role in the wound healing/tissue remodeling process (Leonida & Kumar, 2016). MMP-1 is found to be important in the migration of cells like keratinocytes resting on fibrillar collagen, and also in angiogenesis (Caley et al., 2015).

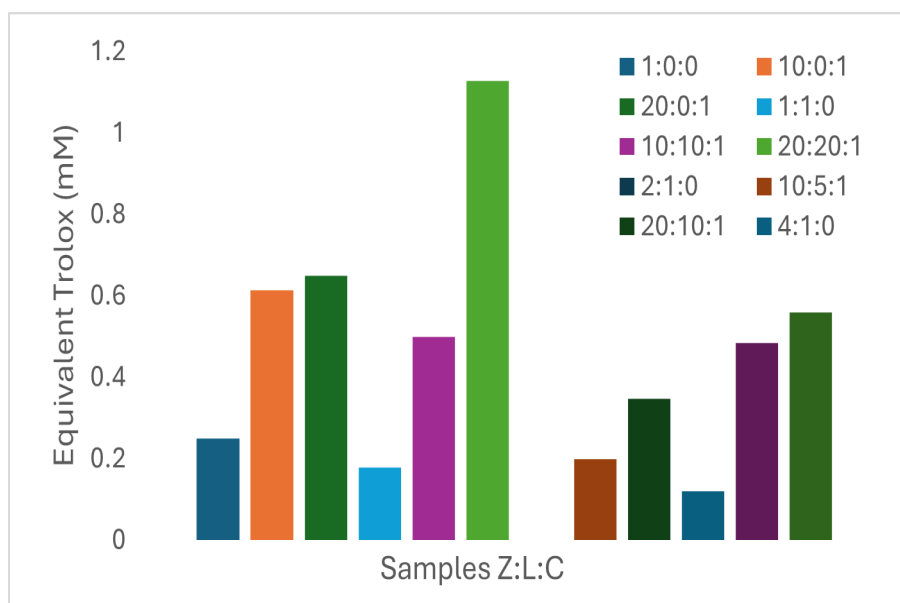


Figure 2. Antioxidant activities of the Z:L and Z:L:C samples, all at 2:3 Z:GA ratio

Kinetic studies conducted for the release of L from composites displayed sustained profiles over 7 days (Figure 4, adapted with permission from (Leonida et al., 2023)). All particles showed initial “burst effect” due, presumably, to the release of L adsorbed on the surface of the lipophilic particles. This is longer (one day) than the same effect recorded for the release of L from hydrophilic matrices (chitosan-tripolyphosphate, ~ 4 h) (Leonida et al., 2018). However, the levels released were too low for practical applications. To address this problem, in another set of preparations, C was added in the synthesis, at two different Z:C ratios (10:1 and 20:1) and using the same Z:L ratios as for the first set. The intent was to modulate the strong lipophilic interactions between Z and L. The release of L was positively impacted by C presence in the matrices and increased with increase in C content in the preparation.

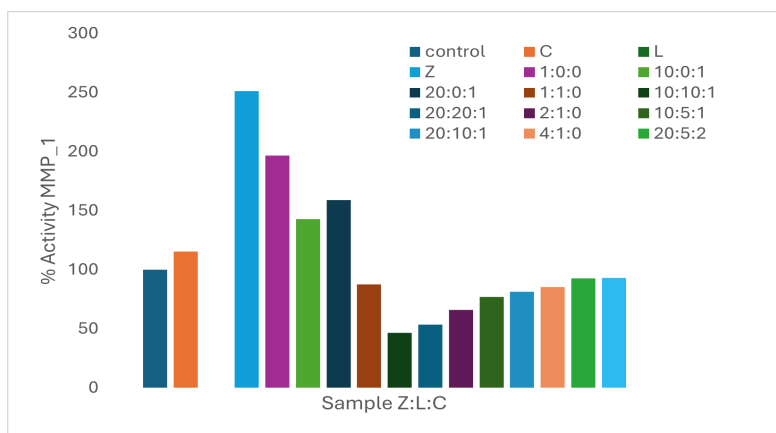


Figure 3. Influence of the Z:L and Z:L:C samples, all at 2:3 Z:GA ratio, on MMP-1 activity

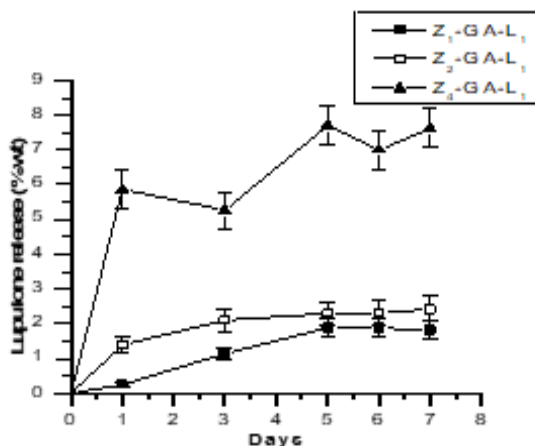


Figure 4. Release of L from Z:L:GA matrices

C presence afforded an increase in antioxidant activity of the composites as well (Figure 3), although more modest than anticipated, since chitosan is a known antioxidant. The lower-than-expected antioxidant activity in both types of particles may be correlated to the difference in time scale between the L release (slow kinetics) and the time required by the antioxidant assay (minutes).

The anticollagenase activity was present and displayed the same variation like in the nanoparticles without chitosan (Figure 4). It is remarkable that the composites displayed anticollagenase activity at all if we take into account the slow kinetics of the release and the difference (several orders of magnitude) between the concentration of L in the assay of the control sample compared to the one in the MMP-1 assay of the particles containing L. The effect of lupulone was powerful enough to mitigate the potent MMP-1 activating effect of zein in the particles. It is more difficult to assess the impact of C presence in the matrix on enzyme activity probably due to the masking effect of the comparatively high Z content.

The nanocomposites reported herein have potential for use in formulations for skin treatment and skin care. The particles containing only Z-GA, powerful activators of MMP-1, have promise for wound healing and tissue remodeling. Addition of filmogenic C may open the possibility of delivery in self-sticking bandages. The presence of L in some of the composites is beneficial for topical applications in which it may mitigate the occurrence of contact dermatitis and pruritus reported in hop pickers (Cookson & Lawton, 1953). The nanomatrices described herein are antioxidant agents, moisture attractors, and collagen synthesis stimulators which makes their promise to defy ageing very clear.

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Carboxymethyl-starch:iodine Complexes as Virucidal Agents

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Abstract: Coronavirus disease (COVID-19), caused by the highly transmissible and pathogenic SARS-CoV-2 virus, led to the global pandemic. While various vaccines have been developed, drugs against SARS-CoV-2 have been primarily focused on repurposing existing antiviral drugs. We report new a new formulation consisting of a carboxymethylstarch:iodine complex (CMS:I₂) as an alternative to the synthetic polymer polyvinylpyrrolidone-iodine virucidal agent. The CMS:I₂ showed a high mucoadhesion and an excellent sprayability, favoring the oropharyngeal administration. By hydrolysis with salivary amylase, CMS:I₂ liberates iodine exerting a strong virucidal activity against human coronavirus hCoV-OC43, an accepted model mimicking the SARS-CoV-2 virus.

The virucidal activity of CMS:I₂ was markedly augmented upon the addition of salivary α -amylase by on-site release of iodine. Importantly, none of the tested CMS:I₂ formulations impacted on cell viability. CMS:I₂ liberates iodine as virucidal activity. It is suggested that CMS:I₂ formulations could prevent the initial phases of SARS-CoV-2 infection by interfering with viral attachment and entry into target cells.

Keywords: Carboxymethylstarch:iodine complex; α -amylase, anti-infectivity, hCoV-OC43 coronavirus, COVID-19

(Title and abstract in Romanian)

Compexe Carboximetil-amidon:Iod ca agenți virucizi.

Rezumat: Virusul SARS-CoV-2, extrem de transmisibil și patogen, a dus la pandemia globală COVID-19. Deși au fost dezvoltate diverse vaccinuri, tratamentele s-au concentrat în principal pe reutilizarea medicamentelor antivirale existente. Prezentăm acum o nouă formulă: un complex CarboxiMetilamidon/Starch:iod (CMS:I₂) ca alternativă la agentul virucid sintetic polivinilpirolidonă-iod, cunoscut ca Betadine®. CMS:I₂, bazat pe un material natural: Amidon, a demonstrat o mucoaderență ridicată, favorizând administrarea orofaringiană. Prin hidroliză cu amilază salivară, CMS:I₂

eliberează iod, exercitând o activitate virucidă puternică împotriva coronavirusului uman hCoV-OC43, un model similar cu virusul SARS-CoV-2.

Activitatea virucidă a CMS:I₂ a fost crescută *in vitro* la adăugarea de α -amilază salivară, cu eliberarea *in situ* de iod (I₂). Niciuna dintre formulările CMS:I₂ testate nu a avut impact asupra viabilității celulare. CMS:I₂ eliberează iod și își exercită activitatea virucidă. Se sugerează că formulările CMS:I₂ ar putea preveni fazele inițiale ale infecției cu SARS-CoV-2 prin interferența cu atașarea și pătrunderea virală în celulele țintă.

Cuvinte cheie: Carboxymethylstarch:iodine complex; α -amylase, antiinfecțive, hCoV-OC43 coronavirus, COVID-19, mucoadesiune, sprayability

Introduction

The COVID-19 pandemic stemming from Severe Acute Respiratory Syndrome coronavirus 2 (**SARS-CoV-2**) (Acter et al., 2020), has led to intensive research seeking to understand its epidemiology and pathogenic characteristics. SARS-CoV-2 and its variants have rapidly spread worldwide and there are no standard treatments (Lothar et al., 2020). Non-pharmaceutical approaches (such as essential oils) have been proposed as virucidal agents (Elsebai et Albalawi, 2022; Wani et al., 2021) with different levels of success (Ayouni et al., 2021; Bohloli et al., 2023).

SARS-CoV-2 is highly transmissible, and infected individuals can be contagious days before and after the acute clinical phase of the disease (Mahyuddin et al., 2020). During infection, viral loads are elevated in the nasal cavity, nasopharynx, and oropharynx (Zou et al., 2020). The nasal cavity and the respiratory epithelium have the highest expression of ACE2 (angiotensin-converting enzyme) receptor, and this is the main receptor for the spike protein of SARS-CoV-2 (Sungnak et al., 2020). In addition to the nasal cavity, the oropharynx is an important way of contamination (Chavda et al., 2023; Hoffmann, 2023).

Aerosol-associated viruses that can persist for hours on surfaces and there is a growing need to develop new easy to apply approaches to reduce transmission of the virus. Standard precautions, including making masks and gloves, may not be sufficient. Recent studies had the impact of iodine-based compounds for disinfection. as part of a transmission reduction plan. For instance, Guidelines from the American Dental Association recommended the use of mouthwash with povidone-iodine **PVP:I** (also known as Betadine®) before dental procedures, in order to prevent COVID-19 transmission (Tessem et al., 2020). PVP-I preparations are well known to be effective against several viruses, bacteria, fungi and protozoa due to the antimicrobial properties of iodine (molecular I₂). From more than a century, iodine has been used for identification of starch. It produces a blue complex with iodine, described as amylose-iodine (Saenger, 1984).

Based on an enhanced ability of carboxymethyl starch to include iodine, the formulation

of a CMS:I₂ complex was proposed as an alternative to the synthetic polyvinylpyrrolidone carrying iodine (PVP-iodine). Given the reported antiviral potential of PVP-iodine against SARS-CoV-2 (Anderson et al., 2020), we investigated the virucidal potential of the novel CMS:I₂ complex on the hCoV-OC43 virus, which belongs coronavirus family, including SARS-CoV-2 with respiratory transmission routes.

HRT-18 cells are a well-documented and established cell line for propagating HCoV-OC43 (Schirtzinger et al., 2022). These cells are highly sensitive to infection, allowing for consistent viral replication.

This report is preceded by several others (Tajer *et al.*, 2025a,b; Ispas-Szabo *et al.*, this issue) reporting various CMS (at different degrees of substitution).

Experimental

Materials - Commercial and “Home-made” alpha-amylase (α -amylase: crude saliva centrifuged and filtered) have been used for comparison.

Preparation of carboxymethyl starch (CMS) powder - To allow chemical modification, starch was first gelatinized by heating in an alkaline aqueous phase (Le Tien et Mateescu, 2017). Carboxymethylation was carried out by treating the gelatinized starch with sodium monochloroacetate (SMCA) in conditions previously reported (Tajer *et al.*, 2025a) to obtain a substitution degree of 0.15 (determined by reverse titration, as per Stojanovic *et al.*, 2005).

Preparations of virucidal agents - Carboxymethyl starch with was loaded with iodine following the vapor loading procedure recently described (Tajer et al, 2025a). Briefly, 1 g powder of CMS was placed for « self-loading » in a beaker containing 2 g of solid molecular iodine (I₂) and the system was maintained in an inclosed desiccator, for one week. The obtained CMS:I₂ powder (with 90 mg iodine/g powder) was used for this investigation. For comparison, Betadine 1 % (povidone-iodine), a commercial product for sore throat gargling and Lugol reagent containing iodine), were used as controls.

Cell lines - For infectivity and virucidal effects, cultured HRT-18, epithelial cell derived from a colorectal adenocarcinoma, were used.

Human coronavirus hCoV-OC43 amplification. A modified version of hCoV-OC43 called hCoV-OC43RLuc (with a Renilla luciferase reporter gene inserted in the NS2 gene) allowed monitoring of infection through the measurement of luciferase activity.

Cell viability and in vitro infection assays – were carried out in conditions recently described by Tajer et al (2025b).

i) *Viral replication*: was evaluated by Luciferase activity (RLU);

ii) *Cell viability*: was evaluated with the 2,3-bis-(2-methoxy-4-nitro-5-sulfo-phenyl)

assay (XTT). It was run in order to examine whether CMS:I₂ or the other control virucides affected or not the viability of HRT-18 cells while exerting virucidal effects. Control samples included virus-free cells (Mock control) was set at 100 % viability. CMS:I₂, Betadine or Lugol and amylases (60 Units/mL, commercial or home-made human saliva) were added alone or together with hCoV-OC43RLuc after 30 min of treatment. Cells were also infected with non-treated viruses (Virus [NT]).

Statistics - Statistical tests were performed using one-way ANOVA multiple comparisons with GraphPad Prism software.

The results on cultured HRT-18 cells confirmed that neither CMS:I₂ nor Betadine nor Lugol did not affect cell viability/metabolism (data presented in Tajer et al., 2025b). On infected HRT-18 cells CMS:I₂ had a slightly lower virucidal effect than Betadine and Lugol (Fig 1), At low concentrations CMS:I₂ was not anti-infective, but at a high concentration it exerted a strong virucidal activity, as Betadine and Lugol (Fig 1).

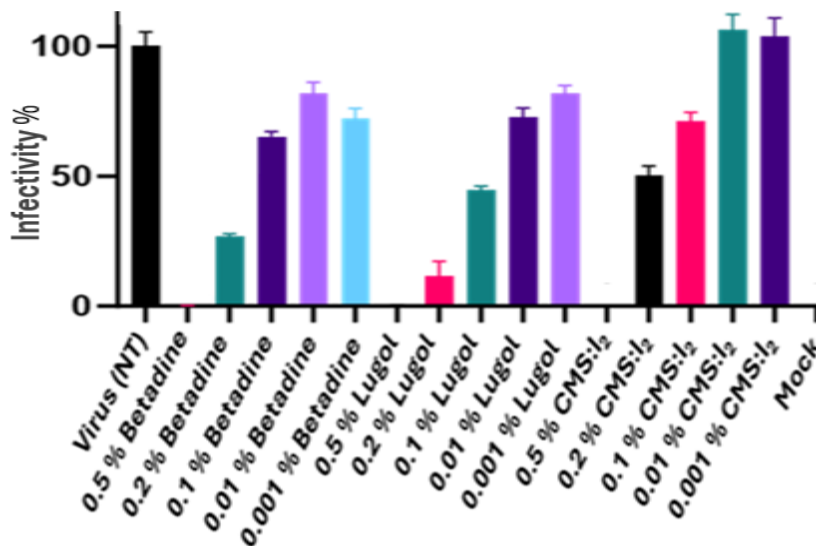


Fig.1- Comparative virucidal effects of CMS:I₂, Betadine or Lugol at different concentrations on hCoV-OC43RLuc virus.

When HRT-18 cells were exposed to hCoV-OC43RLuc treated with CMS:I₂ at various concentrations in the presence of home-made saliva preparations (containing salivary alpha-amylase), the virucidal effect of CMS:I₂ was much stronger (Fig. 2). With the CMS:I₂ at concentrations of 1 % and 5 %, in the presence of saliva, hCoV-OC43 replication was drastically (almost totally) reduced to 0.03 % and 0.006 % respectively, compared to

untreated infected control cells set at 100 % (Tajer et al, 2025b). This powerful virucidal capacity of CMS:I₂ in presence of salivary amylase appears due to the enzymatic hydrolysis of starch chains: consequently, iodine is released *in situ*, opening the possibility to use CMS:I₂ as a sprayable solution for decontamination of the oropharyngeal area. Moreover, this virucidal activity of CMS:I₂ in presence of saliva was clearly higher than those found with Betadine or Lugol at the same concentrations (Tajer *et al.*, 2025b).

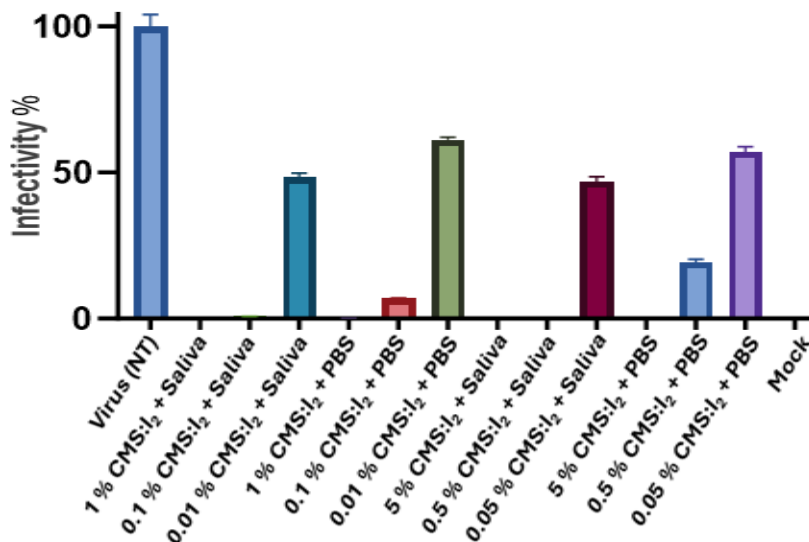


Fig. 2 - Virucidal effect of CMS:I₂ at various concentrations in the presence of human saliva on hCoV-OC43RLuc virus replication.

Worth to mention is that, despite the strong virucidal activity, the viability of host cells was not affected at all by the CMS:I₂ with alpha-amylase (Fig. 3).

We have previously reported unexpected properties of CMS:I₂ complexes, particularly related to iodine inclusion (Tajer *et al.*, 2025a; Ispas-Szabo *et al.*, this issue). Among the peculiar aspects was the spontaneous self-inclusion of iodine into the CMS to form the CMS:I₂ complexes.

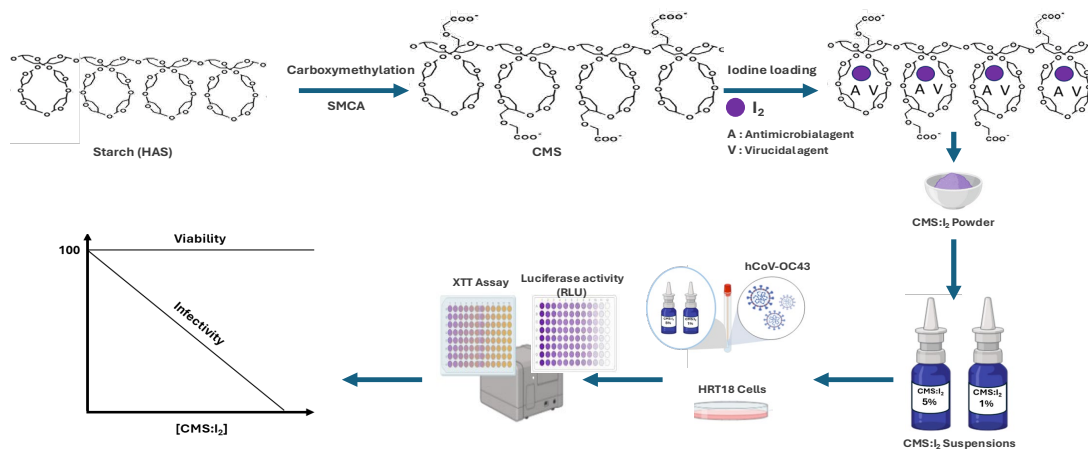


Fig. 3 - Schematic presentation of the virucidal CMS: I_2 action modulated by on site hydrolysis with salivary amylase.

The self-loading phenomenon was found only with CMS (DS 0.15) and not with other tested starch derivatives (such as cross-linked starch). A possible explanation is related to the expanded V-helix structures for the CMS derivatives. The CMS: I_2 , when loaded with iodine, presents an enhanced mucoadhesion and a drastic decrease of viscosity when compared with the unloaded CMS derivative. The unexpectedly lowered viscosity is an important property, allowing thus an excellent spray ability using spray bottles for oropharyngeal administration.

In conclusion, it appears that CMS: I_2 -based formulations could prevent the initial phases of SARS-CoV-2 infection, particularly the viral attachment and replication, reducing the risk of the downstream infection with respiratory viruses. This approach represents a way to reduce transmission of these viruses for individuals that recently were or may be in contact with infected people.

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Formulations Based on Carboxymethyl-starch:Iodine Complexes

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Abstract: There is a major need for novel approaches to limit contamination with respiratory viruses such as SARS-CoV-2 (Covid-19) and influenza. Since viral transmission is by aerosols, the oral and nasopharyngeal decontamination seems of relevance to prevent virus spreading. Carboxymethylstarch (CMS), microspheres of CMS cross-linked with Sodium TriMetaPhosphate (STMP), and high amylose starch cross-linked (CL) with epichlorohydrin HAS-CL were proposed as matrices for iodine inclusion complexes as anti-infective agents. By hydrolysis of CMS matrix with salivary alpha-amylase, the released iodine would act against infective agents. The iodine complexation induced some structural modifications on the CMS network. CMS:Iodine presented enhanced mucoadhesion, a markedly increased sprayability, and a higher susceptibility at amylolysis with alpha-amylase, when compared to unloaded CMS.

Keywords: carboxymethylstarch iodine complexes, mucoadhesion, spray, antiviral agents

(Title and abstract in Romanian)

Formulari pe baza de complecși de Carboximetil amidon

Rezumat: Există o nevoie majoră de noi abordări pentru a limita contaminarea cu virusuri respiratorii precum SARS-CoV-2 (Covid-19) și gripa. Deoarece transmiterea virală

se face prin aerosoli, decontaminarea orală și nazofaringiană pare a fi relevantă pentru a preveni răspândirea virusului. Carboximetilamidonul (CMS), microsfele de CMS reticulate cu Sodiutrimetafosfat (STMP) și amidon cu conținut ridicat de amiloză reticulată (CL) cu epiclorhidrină HAS-CL au fost propuse ca matrici pentru complexi de incluziune a iodului ca agenți antiinfecțioși. Prin hidroliza matricei CMS cu alfa-amilază salivară, iodul eliberat poate acționa împotriva agenților infecțioși. Complexarea iodului induce unele modificări structurale asupra rețelei polimerice a CMS. CMS:Iod prezintă o mucoaderență îmbunătățită, o pulverizare semnificativ crescută și o susceptibilitate mai mare la amiloliză cu alfa-amilază, în comparație cu CMS necomplexat cu iod.

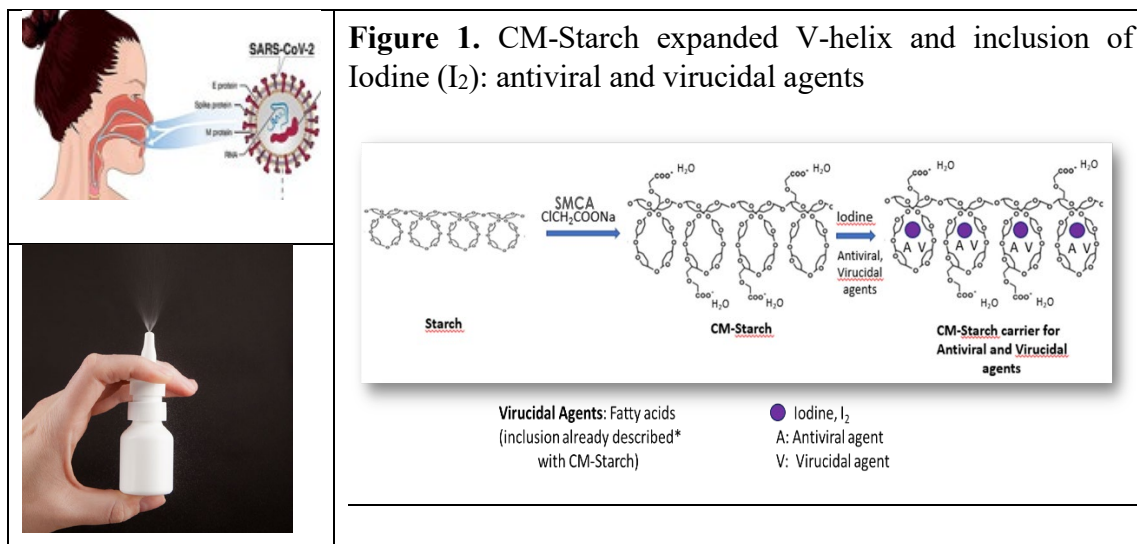
Cuvinte cheie: complexi amidon:iod, mucoadeziune, spray, acțiune antivirală.

Introduction

Coronavirus disease 19 (COVID-19), caused by the highly transmissible and pathogenic SARS-CoV-2 virus, has led to the global pandemic. While various vaccines have been developed, drugs against SARS-CoV-2 have been primarily focused on antivirals/antimicrobials administered by injectable forms. Despite the peaks of pandemic have passed, there are still concerns about a new wave or long COVID-19 affecting many people that can have a wide variety of symptoms that can range from mild to severe and may be like symptoms from other illnesses. These symptoms can persist weeks, months, or years after COVID-19 illness and can emerge, resolve, and reemerge over different lengths of time. Prevention from the very first symptoms may be a very simple and efficient solution. Using a spray with virucidal activity applied directly on the area of mouth and throat can inactivate the virus and eliminate the consequences of infection (Fig. 1).

In this study, we are proposing new formulations with virucidal activity that are based on carboxymethylstarch:iodine complexes (CMS:I₂). By hydrolysis with salivary amylase, CMS:I₂ liberates iodine exerting a strong virucidal activity against human coronavirus hCoV-OC43 - an accepted model mimicking the SARS-CoV-2 virus.

Starch and its derivatives have been widely used in the formulation of a variety of drugs to modulate their release patterns [1]. In this study, carboxymethyl starch iodine inclusion complexes were prepared by aqueous procedures and proposed as new spray formulations to be applied as anti-infective treatment. The hypothesis was that CMS, grafted with polar carboxylic groups, may present expanded V-helices, helping to load higher amounts of iodine.



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Methodology

1. Reagents

Hylon® VII, a high amylose corn starch (HAS, 70 % of amylose), was from Ingredion (Westchester, IL, USA). Sodium monochloroacetate (SMCA), sodium trimetaphosphate (STMP), epichlorohydrin, mucin, gelatin, bacterial α -amylase and human salivary α -amylase were from MilliporeSigma (Darmstadt, Germany). Iodine, KI, NaOH, and HCl were from Fisher (Hampton, New Hampshire, USA).

2. Starch derivatization

2.1. Preparation of carboxymethyl starch (CMS) powder: an amount of 140 g of Hylon VII (corn starch with a 70 % amylose content), was first suspended in approximately 340 mL of water at 55 °C for 20 min under stirring and then an equal volume of 360 mL of 1.5 M NaOH was added with continued stirring for 1 h. Carboxymethylation was carried out by adding 50 g sodium monochloroacetate (SMCA) continuing the reaction for 2 h in the same conditions of stirring and 55 °C [1]. The obtained CMS derivative presented a degree

of substitution ($DS = 0.15 \pm 0.030$) and was hereto called CMS(DS 0.15). Another CMS derivative was obtained exactly in the same conditions but doubling the amount of SMCA from 50 g to 100 g and obtaining a CMS product with $DS = 0.30 \pm 0.080$, hereto called CMS(DS 0.30).

2.2. Preparation of microspheres CMS-MS was done by a water-in-water (W/W) emulsion method in three steps [2]: a) preparation of the continuous phase; b) addition of the dispersed phase: the emulsion; c) cross-linking of the beads: for CMS (DS 0.15) crosslinking, 1.0 g, 1.5 g, or 2.0 g STMP were added to the emulsion under continued stirring for 30 min, to obtain respectively different cross-linking degrees conventionally expressed as percentages of crosslinker (20 %, 30 % and 40 %) used to cross-link the CMS (DS 0.15) materials. The cross-linked CMS derivatives are hereto called CMS-CL20, CMS-CL30 and CMS-CL40, where the numbers represent the percentage of STMP cross-linker reported to the initial amount of CMS to cross-link. The detailed method of MS drying was described previously [2]. The obtained dry CMS-CL20(MS), CMS-CL30(MS) and CMS-CL40 (MS).

2.3. Iodine inclusion: Two methods were tested, for the inclusion of iodine in starch: i) with a Lugol's reagent (solution) and ii) by iodine vapor. i) Inclusion of iodine using Lugol's reagent: iodo-iodide solution ($I_2 + KI$) was prepared in the laboratory (10 g KI and 5 g I_2 in 100 mL water), allowing the inclusion of iodine molecules in the helix structures formed by the starch (iodine retained by Van der Waals bonds). ii) Iodine vapor: 1 g powders of starch derivatives were placed in a beaker containing 2 g of solid molecular iodine I_2 and the system was maintained in a desiccator for one week, checking the mass of each sample at the end.

2.4. Mucoadhesion and sprayability assays: A mucin-gelatin adhesive supports were prepared by casting from a warm filmogenic solution containing 10 % gelatin and 5 % mucin. The adhesion of suspended particles was tested by pipetting 100 μ L of the suspensions of samples onto the mucin or mucin-gelatin plate on the hexagonal weighing dishes containing mucin-gelatin support. For each material, three samples were applied for different times of contact ($t = 0$ s; 120 s and 300 s) to the same support at distance of 10 mm each other. At the end of the interval, the adhesive backing was immediately placed at 45° inclination (time zero) and the time taken for droplets to flow 20 mm down onto the mucin-gelatin surface was recorded and considered to evaluate the relative mucoadhesion of various formulations (Fig. 2) [3]. To test the sprayability of the liquid formulation CMS (DS 0.15): I_2 , the suspension was first homogenized and loaded into a manual spray bottle. The test was performed on a white paper placed to assess the spray distribution. The spray bottle was held approximately 15 to 30 cm from the surface, and an intermittent spray was applied. For sprayability, CMS(DS 0.15): I_2 suspensions 1 % and 5 % were used to estimate the drop

profile splashed on a white paper screen. The sprayed drop pattern was compared to the commercial PVP-I (Betadine) at same concentrations.

2.5. Hydrolysis of iodine complexes by different α -amylase preparations. Commercial human salivary α -amylase, bacterial α -amylase, or crude saliva were assayed by adding 1 mL of each enzyme stock solution (the enzyme concentration were chosen such as to obtain 0, 20, 40 and 60 enzyme units) to 1 mL of 1 % (w/v) Hylon VII, CMS, or CMS:I₂ suspension. The amylolysis with liberation of reducing sugars was carried out by incubating of the mixture at 37 °C for 3 min. The reaction was stopped by adding 1 mL of 3, 5-dinitrosalicylic acid and heating it at 100 °C for 5 min for determination of reducing sugars [4]. One enzyme unit (EU) of enzyme) is defined as the amount of enzyme that releases 1 μ mol of reducing sugar (i.e. maltose equivalent) per minute under the standard assay conditions.

Results

Iodine loading of CM-Starch derivatives

The highest iodine contents (mg/g of starch derivative powder) were for cross-linked High Amylose Starch (HAS-CL10): 95.71 ± 5.1 mg/g, for CMS (DS 0.15): 90.45 ± 2.4 mg/g and for CMS-CL40(MS): 108.27 ± 1.1 mg/g. A higher iodine loading of 95.71 mg/g for HAS-CL10 (the higher degree of cross-linking with epichlorohydrin) than that of 64 mg/g for HAS-CL5 (the lower degree of cross-linking, with only 5 % epichlorohydrin) was an unexpected behavior. Normally, a higher crosslinking could prevent the access iodine to the V-helix of the starch matrix. In our case, the explanation resides on previous observations [5,6] showing that denser cross-linking bridges with epichlorohydrin (8.4 Å) would hinder the formation of hydrogen bonds (4.1 Å) and so will prevent a tight interchain association of cross-linked (HAS-CL), acting as a spacer and affording better access of iodine to its V-helices. The iodine loading (90.45 mgI₂/g) of carboxymethylated material CMS (DS 0.15) with a low degree of substitution (DS 0.15) was higher than that of 18 mg/g of CMS (DS 0.30) with a higher DS. A better fitting of hydrophobic iodine size with the size of the hydrophobic channel of V-type helix cannot be excluded. In the CMS microspheres (MS) cross-linked (CL) with STMP, that the iodine loading increased linearly with the cross-linking degree (cld). The highest loading (108.27 mgI₂ /g) was found at the greatest cld: CMS-CL40 (MS). This can be explained by the previous observation that carboxymethylation obtained by grafting of polar groups would enhance the diameter of the V-helix [6].

The CMS (DS 0.15) exhibited the best iodine retention. This spontaneous reaction is a particularly advantageous loading procedure, taking advantage of i) the property of I₂ to

sublimate and ii) the expanded V-helix form of CMS (DS 0.15) starch. Best iodine inclusion was found only with modified starches presenting expanded V-type helices.

Unexpectedly, CMS:I₂ presents a higher susceptibility at amyolysis and enhanced mucoadhesion and sprayability (Table I).

Figure 2: Mucoadhesion test

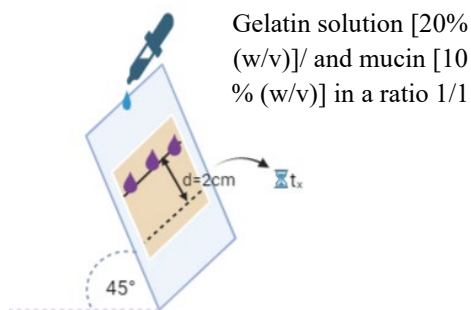


Table I: The effect of iodine loading on mucoadhesion, viscosity and sprayability for CMS

Samples	Viscosity	Sprayability
CMS 1%	10.7	N.D
CMS:I ₂ 1%	1.15	++++
CMS 5%	27.7	N.D
CMS:I ₂ 5%	3.9	+++
CMS-MS(CL 40%) 1%	0.52	N.D
CMS-MS(CL 40%):I ₂ 1%	0.66	++
BETADINE® 1%	0.93	+++
BETADINE® 5%	1.43	+++

It was of interest to evaluate the mucoadhesive characteristics of CMS:I complexes in view of further utilization for buccal and oropharyngeal. A much stronger mucoadhesion measured as a longest runtime (480s) was found for CMS (DS 0.15):I₂ formulations when compared with the commercial product Betadine. A possible explanation of higher mucoadhesion for CMS(DS 0.15):I₂ can be related to the nonpolar iodine hosted by the V-helix, that would trigger a repulsion of outer carboxylic groups, enhancing thus the adhesion. An increase in mucoadhesion was found with all starch materials when loaded with iodine (Table 1), important feature for further applications of CMS(DS 0.15):I₂ complexes as microbicial agents. The unexpected decrease of viscosity for loaded CMS(DS 0.15)I₂, can be explained by the non-polar iodine inside the V-helix, generating repulsive interactions with outer polar carboxylic groups, enhancing the overall hydrophilicity and decreasing the viscosity.

The amyolysis rates with various alpha-amylases were determined against 1 % Hylon VII, or CMS(DS 0.15), or CMS(DS 0.15):I at various enzyme concentrations: 20–60 U/mL for both commercial salivary and bacterial α 2 -amylases) or with 0.2–1.0 mL for crude saliva. The amyolysis rates were quantified by production of reducing sugars (mainly maltose) at 37 °C. The highest amount of reducing maltose equivalent sugars was liberated from CMS (DS 0.15)I₂, followed by CMS (DS 0.15) and Hylon VII, respectively. A similar behavior was observed with these starches treated with crude saliva (data not shown).

Conclusion

Obtained starch derivatives CMS with a degree of substitution (DS) between 0.15 and 0.30, microspheres cross-linked with STMP CMS-CL(20,30.40%)(MS), and starch cross-linked with epichlorohydrin HAS-CL(5,10) were used as polymeric carriers of iodine. This spontaneous inclusion of iodine was found for CM-starch only and has not occurred with non-derivatized starch. It appeared that iodine complexation induced some structural modifications on the starch network. The CMS:I₂ showed high mucoadhesion and a remarkable sprayability, favoring the oropharyngeally administration.

It is suggested that CMS:I₂ formulations could prevent the initial phases of SARS-CoV-2 infection possibly by interfering with viral attachment and entry into target cells.

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Exploring Artificial Intelligence-based Optimizations for Designs Involving Active and Passive Components: Theories, Methods, Implementations, and Applications

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Abstract: The cooperative presence of active and passive devices, such as amplifiers and antennas, is well-settled in wireless communication systems. Due to the complexity of such systems, their design requires the use of advanced methodologies along with optimization methods. Recently, Artificial Intelligence (AI) has proved its effectiveness in various fields and applications, leading to the acceleration of design and optimization processes. Therefore, this paper aims to present various methodologies used in the shared design and optimization of amplifiers and antennas using the AI method in terms of optimal structure arrangement and configuration sizing. In this paper, the practical procedure for implementing AI for the design and optimization of large-scale projects is described. In short, the use of this method (i.e., AI) requires the collaboration of electronic design automation (EDA) and numerical analyzer tools, simultaneously leading to the creation of an automated environment. Readers of this study will gain an overview of AI implementation for high-dimensional projects. Depending on the need determined by the specific project, one or more of the methodologies described in this paper may be used.

Keywords: Artificial intelligence (AI), automation, antenna, neural networks (NN), optimization, power amplifier (PA).

(Title and abstract in Romanian)

Explorarea Optimizarilor Bazate pe Inteligență Artificială pentru Proiecte care Implică Componente Active și Pasive: Teorii, Metode, Implementari și Aplicații

Abstract: Prezența cooperativă a dispozitivelor active și pasive, cum ar fi amplificatoarele și antenele, este bine stabilită în sistemele de comunicații fără fir. Datorită complexității acestor sisteme, proiectarea lor necesită utilizarea unor metodologii avansate împreună cu metode de optimizare. Recent, Inteligența Artificială (IA) și-a dovedit eficacitatea în diverse domenii și aplicații, conducând la accelerarea proceselor de proiectare și optimizare. Prin urmare, această lucrare își propune să prezinte diverse metodologii utilizate în proiectarea și optimizarea comună a amplificatoarelor și antenelor folosind metoda IA, în ceea ce privește aranjamentul optim al structurii și dimensionarea configurației. În această lucrare, este descrisă procedura practică pentru implementarea IA în proiectarea și optimizarea proiectelor de mare anvergură. Pe scurt, utilizarea acestei metode (adică IA) necesită colaborarea dintre unelele de automatizare a proiectării electronice (EDA) și cele de analiză numerică, conducând simultan la crearea unui mediu automatizat. Cititorii acestui studiu vor obține o imagine de ansamblu asupra implementării IA pentru proiecte de dimensiuni mari. În funcție de necesitatea determinată de proiectul specific, una sau mai multe dintre metodologiile descrise în această lucrare pot fi utilizate.

Keywords: Inteligența Artificială (IA), automatizare, antene, rețea neurale (NN), optimizare, amplificator de putere.

I. INTRODUCTION

With the development of communication systems, data traffic is increasing exponentially, resulting in various new issues and drawbacks. These challenges can be formulated by considering the necessity for mobility issues [1], big system capacity [2], energy consumption [3], performance metrics [4], and so on. Hence, the implementation of powerful and suitable optimization methods will help in enhancing the overall performance of systems. Recently, the Artificial Intelligence (AI) method has proven its novelty in solving high-dimensional designs, leading to improved performance of devices in terms of targeted output specifications.

In [5], the Machine Learning (ML) method is employed for reducing the calculation time, leading to predicting the path loss model in indoor scenarios in a much faster way.

The ML method is employed in [6] for an analog radio-over-fiber link, leading to enhancing receiver sensitivity. The combination of a Reinforcement Learning (RL) algorithm and a Deep Q-Neural Network (DQN) is employed in [7] for managing congestion control under a User Datagram Protocol environment. The RL is also executed in [8] to achieve robust and low-overhead security in the reconfigurable Power Amplifier (PA) designs. The Federated Learning (FL) is another learning framework that is executed over wireless networks. In [9], the FL method is used for reducing the total energy consumption over all devices. Kee et al. in [10] present detailed information about the various types of ML techniques for channel coding and describe the importance of this method for their problem.

AI methods have also been used recently in the field and domain of PAs. In [11], a Neural Network (NN) is employed for reducing baseband intermodulation distortion, which is important for Digital Pre-Distortion (DPD). A phase-normalized recurrent neural network is employed in [12] for linearizing PAs in high-bandwidth communication systems by focusing on the memory effects. Since the DPD issue is significant in PA designs, a Deep Neural Network (DNN) is executed to minimize the computational complexity and memory footprint. In [13], the DPD issue is studied with the help of Recurrent Neural Network (RNN) for enhancing the overall performance of PA.

Alike the use of AI in the PA designs, it is also executed in the domain of passive devices as antenna designs. In [14], the NN is used for analyzing and evaluating the Specific Absorption Rate (SAR) that results in reducing test time costs. The Convolutional Neural Network (CNN) is used in [15] in the field of adaptive broadband digital beamforming for the generation of beamforming Weights. With the help of synthetic NN, in [16], a reconfigurable metasurface is presented, which solves the limit of metasurfaces' intrinsic scale.

By reviewing the up-to-date references, it is observed that *the AI and ML methods are widely used in designing and optimizing wireless systems, PAs, and antennas for various goals*. This study is devoted to presenting the use of AI in modeling and sizing the high-dimensional PA and antenna designs, leading to improving each of their overall performances. The remainder of this chapter is as follows: Section II describes the suitable generated environment for implementing AI, leading to the design and optimize active and passive devices. Section III provides a summary of some designed and optimized PAs and antennas through the AI method. Finally, Section IV concludes this paper.

II. ENVIRONMENT CREATION FOR AUTOMATED OPTIMIZATION PROCESS

The AI methods are typically implemented in interface-oriented numerical analyzer environments such as Octave, MATLAB, Python, R, etc., in which various ML libraries are

included [17]. From another point of view, active and passive devices such as PA and antenna are designed in the

Electronic Design Automation (EDA) tools, software tools suitable for designing integrated circuits and printed circuit boards [18]. Some of the EDA tools are OrCAD, Cadence, Cadence Design Systems, Ansys, Keysight Technologies, SPICE simulator, etc. Hence, implementing AI methods for electronic computer-aided design requires a connection between two different environments, as numerical analyzers and EDA tools. This requires a cross-platform design; otherwise, human inference is needed. Figure 1 presents the general overview of the various environment connections between EDA tools and numerical analyzers, leading to the design and optimizing diverse active and passive devices.

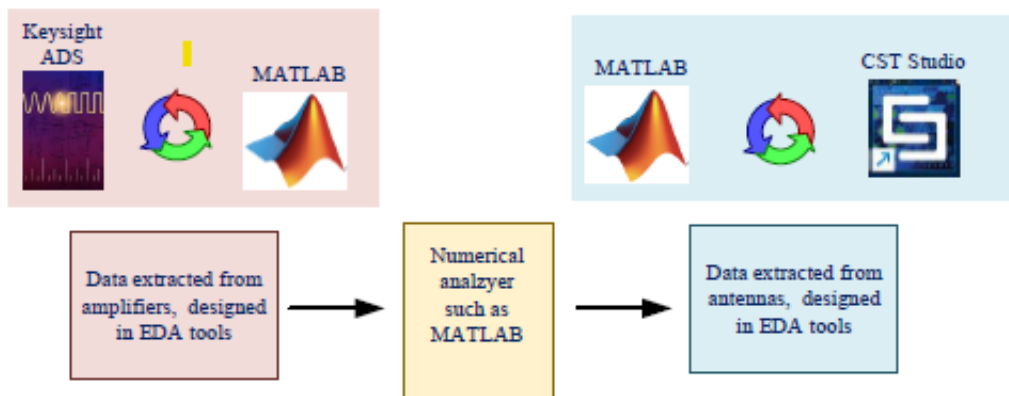


Fig. 1. Connection between EDA tools and numerical analyzers.

The main core of the presented environment is the numerical analyzer that manages all the optimization processes in which AI methods are employed. Here, the numerical analyzer is operating in the forward, and EDA tools are operating in the background prompted by the numerical analyzers [19].

III. PRACTICAL IMPLEMENTATION OF AI FOR DESIGNING AND OPTIMIZING ACTIVE AND PASSIVE CIRCUITS

After constructing an automated environment between EDA tools and numerical analyzers, the design and optimization process for PA and antenna circuits can be executed. Firstly, this section is devoted to presenting the procedures leading to constructing the initial structures of PAs and antennas. Afterward, the methodologies for obtaining the optimal

design parameters are explained.

A. Generating the initial structure of PA and antenna

Configuring the initial structures of active and passive designs is not straightforward, and mostly, it depends on the designers' experience. For instance, the general structure of any PA includes input and output matching networks (MNs) with the substitution of transistor between these networks as shown in Figure 2. Hence, configuring these MNs is complex, and designers aim to construct the various networks with advanced methodologies.

To tackle this problem, there are various reported methods as below:

- Simplified Real Frequency Technique (SRFT),
- Classification DNN, • Bottom-Up Optimization (BUO),
- Top-Down Optimization (TDO).

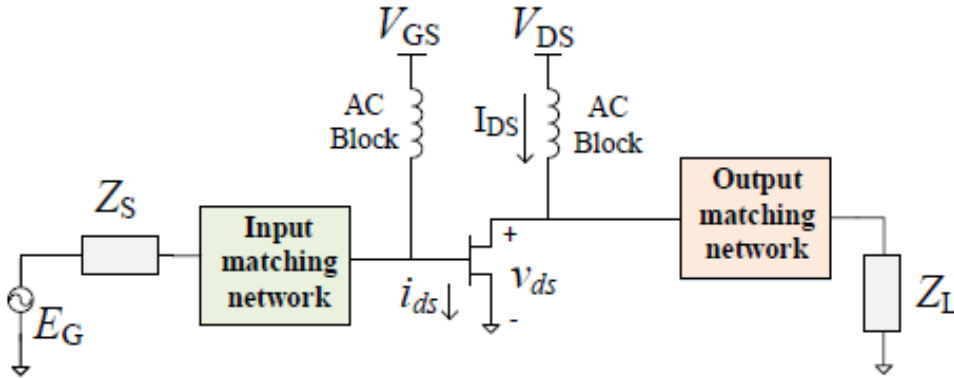


Fig. 2. General structure of any PA.

The SRFT can be a successful candidate for presenting the initial configurations for the input and output MNs by inserting the load-pull data to this method [20]. This method results in various MN typologies that vary in the number of components, including either capacitor/inductor or transmission lines (TLs). These numbers are defined by the numerator polynomial as defined in Eq. (1) in which the starting matrix (i.e., $h_0 = [\mp 1 \ 0]$) has the size of $1 \times m$, for all $m \geq 3$.

$$h(\lambda) = h_1 \lambda^n + h_2 \lambda^{(n-1)} + \dots + h_n + 1 \quad (1)$$

By differing the number of m in the matrix of the SRFT method, various configurations are achieved. Hence, deciding on the optimal configuration is critical. For this case, in [21], a methodology based on the classification DNN is presented, leading to the prediction of the optimal MNs based on the performance of the transistor model. Figure 3 presents the

general structure of the proposed classification DNN presented in [21] in which the input specifications are phase distortion (AM/PM), amplitude distortion (AM/AM), drain efficiency (η_D), and power gain (G_p). More details regarding the construction of classification DNN are also presented in [22].

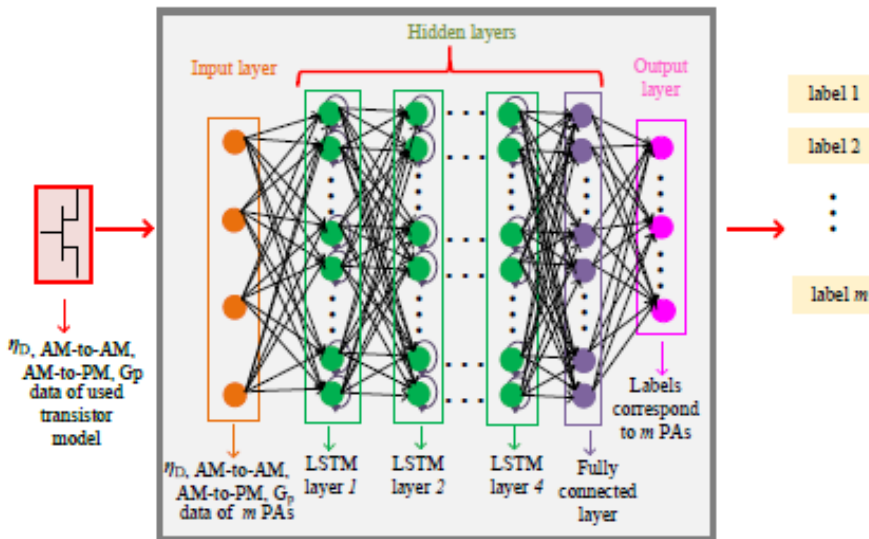


Fig. 3. Classification DNN presented in [21] for determining the optimal MNs for the PA design.

The BUO is another method leading to configuring system-level and/or circuit-level designs by decomposing into sub-blocks. This methodology starts with the lowest level and is increased sequentially and hierarchically up to achieve suitable output performance. On the other hand, the TDO method can be employed first to analyze the whole system and then break the entire system into small pieces [23]. Figure 4 presents the general flowchart of two optimizations leading to the configuration of the initial structure of active and passive designs.

The BUO and TDO methods are also employed in configuring antennas as well. Figure 5 presents the BUO method in which the optimization process starts with one TL and then is increased in the number of TLs, leading to the configuration of the antenna's structure. An example of demonstrating the TDO method is presented in [24]. Opposite to the BUO method, the TDO method is used to configure the structure of biomedical Multiple Input Multiple Output (MIMO) antenna in which firstly the biomedical layers are constructed and afterward the whole shape of the MIMO antenna is configured. Finally, the small parts of the MIMO structure are settled down (See Figure 6).

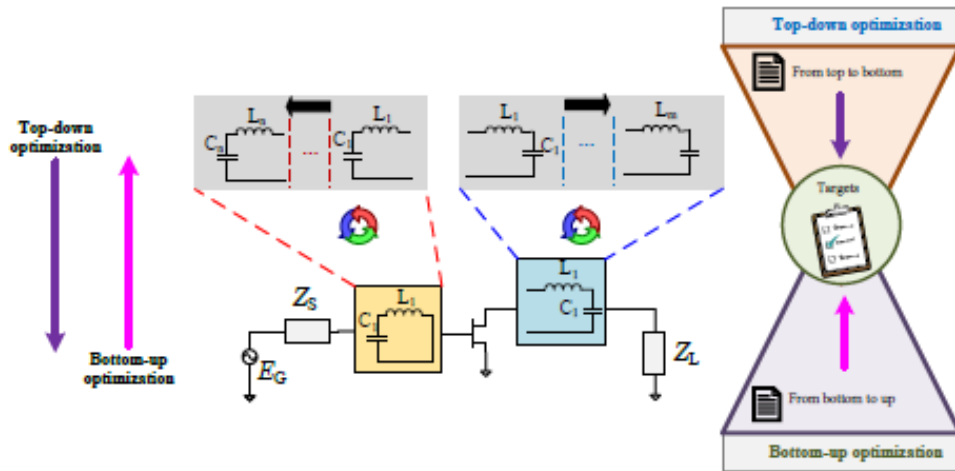


Fig. 4. A general view of process performance of BUO and TDO methods for designing a PA [19].

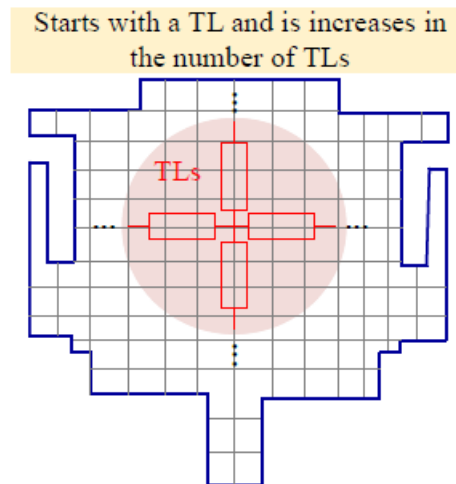


Fig. 5. Process of BUO in configuring the antenna structure.

B. Sizing of design parameters included in the configuration

The NN is a flexible structure for which the input layer and output layers can be defined by the designer. Hence in various recently published papers, AI methods are employed for sizing the design parameters of active and passive devices. Figure 7 shows the general structure of DNN where Long Short-Term Memory (LSTM) layers are used. By training accurate DNN, the determined specifications at the output layer are predicted for any given specifications in the input layer.

In [22], three specifications of PA in terms of P_{out} , G_p , and efficiency are optimized concurrently by implementing the Thompson Sampling Efficient Multiobjective Optimization (TSEMO) to the output layer of proposed LSTM-based DNN. This method (i.e., NN) can also be used in sizing the design parameters of the antenna. In [25], one-layer NN is employed for sizing the antenna for which the input layer presents the design parameters such as width and length of the antenna and output layer predicts the gain of the antenna.

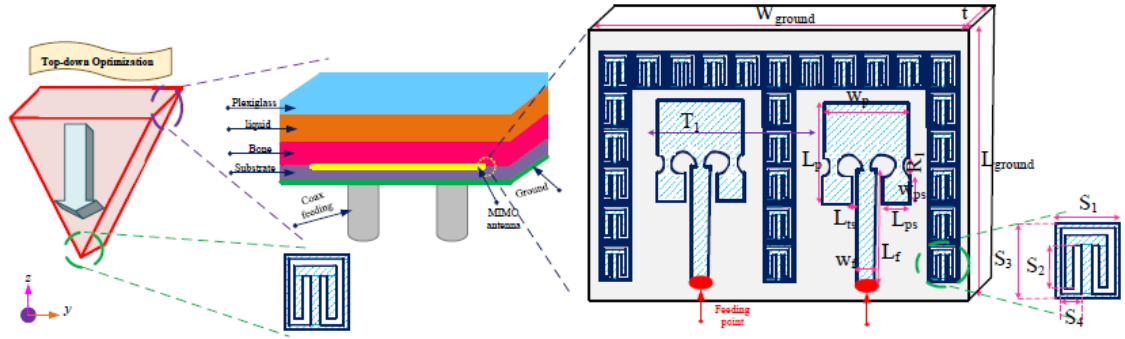


Fig. 6. TDO method for constructing the implanted MIMO antenna (width and length are in mm unit) [24].

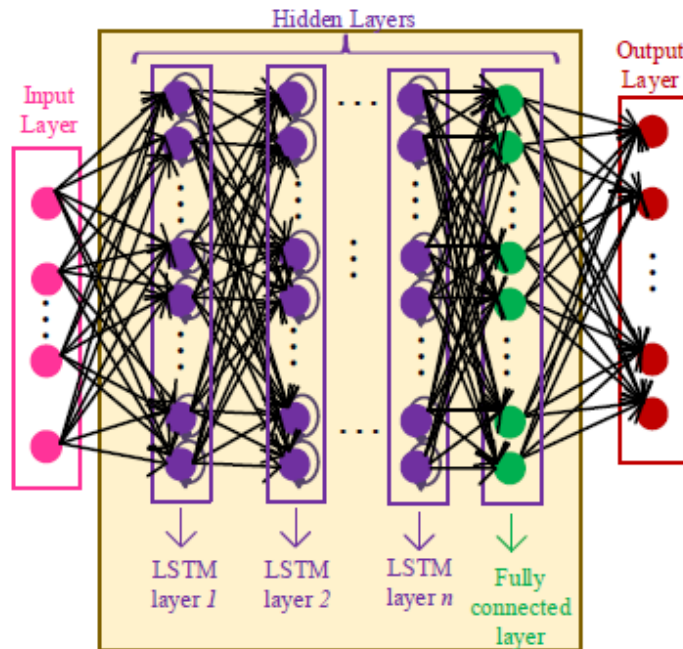


Fig. 7. General structure of DNN with LSTM layers [19].

IV. CONCLUSION

Designing and optimizing amplifiers as active devices, and antennas as passive devices are not straightforward; additional efforts are required. The AI methods prove their effectiveness in designing high-dimensional designs leading to present high-performance devices. For this case, this paper is devoted to presenting the various AI methods applied for designing and optimizing amplifiers and antennas. Implementation of AI methods for these designs requires the collaboration of EDA tools and numerical analyzers. Hence, firstly, a suitable environment must be created. Afterward, the optimal configuration of the PA and antenna can be structured through SRFT, BUO, TDO, and/or classification neural networks. Finally, neural networks (preferably regression networks) can be trained to optimize the targeted specifications of designs and achieve the optimal design parameters. By using the AI methods, human inference is reduced, leading to fewer errors, and the time consumed for optimizing these designs is reduced.

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History

Romania from Great War to Frozen Security Paradigm. A Geopolitical Approach to the Main Characteristics of Romania's National Security Throughout The 20th Century

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Abstract. This article, which focuses on a well-defined period in the recent history of Romania, is a revised fragment that is part of my doctoral thesis in international relations, presented in France. Romania is, without a doubt, one of the main geostrategic actors of the region. Through its geographical location west of the Black Sea, through its demographic, military and economic potential, Romania is able to position itself in the group of Black Sea riparian powers, such as Bulgaria, Ukraine, Moldova, Russia, Georgia, Armenia and Turkey. From a cultural point of view, Romania is the only Latin state in the area, but the beneficiary of a double identity, both Western and Eastern. As we have already mentioned, the country is located at a crossroads of the region, being, throughout history, the first European bastion with the mission of blocking the advance of migratory peoples towards the West. Thus, Romania's security values are not at all recent, having their roots in antiquity. The bivalent ancestry, Western and Eastern, represents an additional asset for Romania but also for the West. Trained in Western schools, Romania's top leaders have contributed to the transformation and development of modern Romania, knowing how to combine the Western spirit with the traditions of Eastern civilization, in a way that allows social progress in this part of the world. National security has always been a concern for the political class of modern Romania. Unfortunately, until the end of the Cold War, national debates in this area were permeated by a damaging policy inherent to totalitarian regimes. Romania had to reshape its national strategy throughout history according to the different regional hegemonies that operated in this part of the world. These transformations were

determined by the major changes in the global security environment that affected the regional security framework. Analyzing Romania's position on the international stage, we come to the conclusion that its role must be approached through the prism of its sensitive position in the region. As a dual member state of NATO and the EU, it fulfills a defensive mission for Europe. To the same extent, it plays a defensive role for the Black Sea region through its defense and international policies, thus becoming a regional exporter of security and stability. Romania's integration into European organizations transformed the Eastern Black Sea littoral into an area controlled by Western allies. Thus, the entire European integration process ensures NATO's rapid and efficient access to the Middle East, and the entire region has passed, after the collapse of the Eastern European regimes, into the Western sphere of influence.

Keywords: Greater Black Sea Region, Warsaw Treaty, North Atlantic Treaty Organization, National Security, Great Romania, Romanian Army, communism, Soviet invasion.

National security has always preoccupied the political class of modern Romania. Unfortunately, until the end of the Cold War, national debates in this area were imbued with a damaging policy inherent to totalitarian regimes. Romania had to reshape its national strategy throughout history according to the various regional hegemonies that operated in this part of the world. These transformations were determined by the major changes in the global security environment that affected the regional security framework.

The period before the Great War was marked by a dangerous underestimation of national security policy. A political class subservient to clan interests often placed its own interests above national goals.

Romania was at that time a dismembered state, with large portions of territory under Russian (Bessarabia and Northern Bukovina), Hungarian (a large part of Transylvania) and Bulgarian (the Cadrilater) occupation. In 1914, Romania had to endure the pressure of the Great Powers to enter the war on the side of one camp or another. However, following its cultural and historical affinities, but especially as a result of promises from France that it would support the unification of Romanians from all provinces after the war, Romania opted for the Entente camp to the detriment of that of the Central Powers. This decision proved to be wise, considering that, after the war, the country found itself in the camp of the victors.

The interwar period marked a phase of significant economic growth for the unified Greater Romania, thanks to the national consensus and euphoria after the Great War. However, the rise to power of the Bolsheviks in Russia, a state with an insatiable appetite for expansionism to the detriment of all its neighbors, the emergence of the Nazi and fascist

regimes in Germany and Italy, as well as the increasing international isolation of Romania's former allies (France and Great Britain), constituted great threats against Romania, which found itself alone in the front of two great enemies, Nazi Germany and the Soviet Union. Thus, in 1940, with the help of those two great enemies, as well as two neighboring states, the great territorial amputations took place through which Romania, defenseless, ceded Bessarabia and Northern Bukovina to the USSR, Northern Transylvania to Hungary and the Cadrilater to Bulgaria.

In 1940, Romania opted for a conjunctural alliance with Nazi Germany, abandoning the guarantees of Western powers that were increasingly isolated on the international stage, a decision that could not prevent territorial amputations. The decision to fight alongside the Axis powers ultimately proved to be disastrous for the country, because at the end of the war it found itself on the camp of the losers. Although it regained Transylvania through the Paris Peace Treaty, Bessarabia, Northern Bukovina and the Cadrilater remained lost, apparently forever for Romania. Western powers, being far away and didn't help Romania.¹ Transylvania's return to the Motherland proved to be the beginning of a long period of territorial disputes between Romania and Hungary. Although communist ideology apparently froze the subject of Romanian-Hungarian confrontations, there was never any peace over this subject, and the end of the Cold War reopened this old wound, a subject of dispute between the two neighboring states.

Soviet success can be attributed to several factors, with the most significant being patriotism, national resilience, and the leadership of Stalin.²

The establishment of the communism in Romania consecrated the closure of the country in the "*camp of the states of popular democracy*". Officially, the independence, sovereignty and integrity of the country were guaranteed by the new "*popular*" Romanian army and by its faithful ally the Soviet Union. The process of communization of the Romanian Army brought the cadres of the old Royal Army into a dramatic situation, many of them being massively dismissed and thrown into the sinister communist prisons by the apparatchiks and political puppets of the new communist army. The communist Romanian army itself represented the greatest risk to Romania's national security, because in the event of a Soviet invasion, no Romanian soldier would have opposed the invading troops.³

[1] McMeekin, Sean Stalin's War: A new History of World War II, 275, Basic Books, April 20, 2021, 1541672798

[2] Overy, Richard, Russia's War: A History of the Soviet Effort: 1941-1945. Epilogue. Penguin Books, August 1st, 1998, 9780140271690

[3] Obviously, our reasoning refers to the early years of the Romanian Army's communization, a period when it was effectively filled with the soldiers of the "Horia Cloșca și Crișan" and "Tudor Vladimirescu" Divisions, the famous large units formed by Romanian volunteers, indoctrinated with communist ideology after their captivity in the USSR. To these elements are added the political officers (apparatchiks belonging to the Nomenklatura and political puppets) tasked

The equipment, training and supply of the Romanian Army left much to be desired, while military commanders were trained in large numbers in Soviet military academies, where most of them were recruited by the GRU and KGB. Consequently, the feeling of belonging to the national values of the Romanian Army was almost nonexistent in the society of that historical period.



Figure 1 Entry of the Tudor Vladimirescu division in Bucharest in August 1944.
Below: King Michael I (right) reviewing the troops with General Nicolae Cambrea.

Source: Wikimedia

The Warsaw Treaty consecrated the presence of the Soviet troops on the national territories of the communist member states. Romania's national security was subordinated to the doctrinal and political-military concepts of the Soviet Union. The Romanian communist regime, obedient to the Kremlin, had proclaimed the supremacy of communist ideology, Soviet military strategy and doctrine. The development of a national defense strategy Romania's image within the Treaty, from a faithful and obedient ally of Moscow to a "maverick", whose marginalization in decision-making at the organizational level was increasingly evident, as Bucharest's attitude become increasingly hostile against the Pact.

The essential component of the new Romanian foreign policy adopted by Nicolae

with indoctrinating the military personnel. This situation changed radically after the takeover of power by Nicolae Ceaușescu, a national leader who, at that time, distanced himself from the Russians through his nationalist policy. (N.B.)

Ceaușescu consisted in the emancipation of Romania from the political tutelage of the Soviet Union. The Romanian leader considered it important for Romania to create its own path of development, consecrating as fundamental principles of Romanian foreign policy mutual respect and equality between states, within international relations. A new defense doctrine was developed on this occasion, and new and promising perspectives opened up for the national defense industry, with the ultimate goal of completely eliminating imports of Soviet equipment and armaments. However, the practical application of this goal proved to be extremely difficult, due to the complexity of the task, the high standards to be respected, as well as a national defense doctrine, was impossible to achieve at that time. The withdrawal of Soviet troops from Romania in 1958 and the takeover of power by Nicolae Ceaușescu in 1965 completely changed the strategical situation. On this occasion, the nationalist-communist ideology replaced proletarian internationalism, and this changed in military production, as well as the lack of a qualified workforce in the field.

The 1970s decade marked an important step for Romania's national security. The concept of "the struggle of the entire people" was transposed by the communist regime into a scientific structural framework for the first time in Romanian history. A new national military doctrine was developed. Thus, practically every member of Romanian society, every citizen of the Socialist Republic of Romania was forced to participate in the defense effort of the socialist state, starting at an extremely young age. For the first time, the Romanian cities were spoken of as "fortresses of labor, struggle and defense of the entire people". The participation of all workers, peasants and intellectuals in the paramilitary formations as part of the Patriotic Guards was mandatory, becoming a mass phenomenon. The children of Socialist Romania were conscripted from the age of 5 into the political organizations of the "Falcons of the Homeland", nurseries of pioneer and communist youth organizations. Thus, the militarization of Romania had become total.

Although Romania was a full member of the Warsaw Pact, the defense plans were developed by the communist leaders in a multidirectional manner, according to the new national doctrine that considered that a possible attack against Romania could come from any geographical point, including from the Warsaw Pact allies. This proved to be a unique case among the members of the Treaty. The latter's official doctrine, developed by the Soviet Union, provided that an attack against the socialist states could only come from the NATO member states, with the United States as the main enemy, and not from the socialist states, a fact that was however contradicted by reality.⁴ As a result, the WPO's war plans⁵ were

[4] E.g. the cases of the uprising in the German Democratic Republic (1953), the rebellion in Hungary (1956), and the textbook example of the invasion by the socialist states (except Romania) of Czechoslovakia (1968) (N.B.)

[5] Warsaw Pact Organization - WPO (N.B.)

designed taking into consideration the foreseeable directions of a massive offensive initiated by NATO against the socialist camp. Of course, each member state of the Treaty was assigned specific tasks in the case of overall missions.

Given Romania's national particularities (its geostrategic position) as the only socialist state surrounded by socialist states, taking into consideration its outdated military equipment, as well as its reputation as a "maverick" within the organization, its role in the defense structures was of secondary importance, with Romanian troops being intended to carry out missions in the second echelon of the military structures, operating with reduced numbers of troops.

This strategic duality of Romania (the existence of a national defensive doctrine in which the enemy could also be a socialist state, as well as its role as a secondary power within the Treaty), made Romania a particular case in the Wider Black Sea Area. From the same perspective, the inconstancy and duplicity of the Romanian communist leaders weakened Romania's overall position during the Cold War.

Bucharest could no longer rely on the solidarity of the other socialist states in the same camp, and for them, Romania represented an unfaithful, unstable, recalcitrant ally, which, through its leaders, asked uncomfortable questions at every meeting of the Treaty, showing obvious nationalism attitude. At the end of the communist era, Romania represented for Western Europe a closed country, totally isolated from the international community, led by a tyrannical regime. For the other socialist leaders of the pre-transition period to capitalism, Ceaușescu represented the "scapegoat" for the deplorable situation in which Romania found itself before the outbreak of the events of December 1989, which put an end to that regime. Although the Romanian Revolution managed to definitively overthrow a criminal regime, on the other hand it created a breach in Romania's national security.

The end of the Cold War again changed the status of the Black Sea. The dismemberment of the Soviet Union changed the number of riparian states. (having Russia, Ukraine, Romania, Bulgaria, Turkey and Georgia). The new independent states, Ukraine, Georgia and Armenia, (although it is not found among the riparian states, Armenia has its geopolitical weight in the region) have "complicated" the regional geostrategic environment even more.

The Pontic file was marked after the fall of communism by an unprecedented fluidity of events. New risks, threats and dangers complete an already very loaded picture of the dissensions between the regional actors. Unpredictability has become a basic term in the regional security equation. The old union republics, with the fall of the Soviet regime, have found their own identities, aspirations for independence, but also pride. Cultural and ethnic fault lines are becoming more and more visible, fully contributing to the "thawing of frozen conflicts". (Transnistria, the Ukrainian problem, Crimeea, Georgia, Nagorno Karabach)

The new security environment entails new conflicts that redefine the states in the region and which have immense chances of spreading and contaminating the neighboring regions. Moreover, cross-border organized crime, terrorism, secessionism, ethnic and territorial disputes, religious fundamentalism, nationalisms, create the image of a convulsive society. We will add to these phenomena the difficulties of the transition to a open market economy, economic, political and social restructuring, accompanied by a strong recrudescence of corruption. The inability of the rulers to master these realities, as well as the strong decrease in the credibility of the political class of the new states, are transformed into real threats to the national security of the states in the region. The fall of communism dramatically changed the security and defense architecture of the Wider Black Sea Area. Before the collapse of the USSR, WPO and NATO troops were positioned in the region face to face. This represented an important stake in the fight for global strategic supremacy, having as main advantages, important strategic objectives, extremely well-placed Soviet naval bases in the Black Sea area, Red Army radars based on Snake Island, which monitored the movements of the 6th Fleet in the Mediterranean, American military bases in Turkey and last but not least the Bosphorus and Dardanelles Straits.

Until 1991, four states from two major political-military organizations (the North Atlantic Treaty Organization and the Warsaw Treaty Organization), the Soviet Union, Turkey, Bulgaria and Romania, shared the shores of the Black Sea. The dissolution of the Soviet colossus doubled their number, through the emergence of new states. Thus, the new configuration includes Bulgaria, Romania, Ukraine, Moldova, Russia, Georgia and Turkey. After the release of positive energies on the occasion of the fall of communism, a dark future was foreshadowed for the states in the region.

In the current post-Cold War framework, a new security paradigm replaces the specific security environment of the Cold War, a conflict based on deterrence, which ensured regional stability and security. The new threats, vulnerabilities, challenges and asymmetric risks that have emerged since then have demonstrated an undeniable reality, that the philosophers and dialecticians of Marxism-Leninism have analyzed, debated, foreseen and accepted the specific effects of the transition of society from capitalism to socialism. However, no one has been able to foresee the process of transition from socialism to capitalism.

Under these conditions, the framework of cooperation between the states belonging to the socialist bloc was suppressed and replaced with a “frozen” security system whose main characteristics are distrust, suspicion, threat, dissension, competition in all areas, lack of cooperation to ensure a climate of stability. Neighboring states were perceived as potential enemies, and Russia set out on the path of recovering its old imperial status.

These elements form, in our opinion, the substance and core of the “frozen security paradigm” after the Cold War. At the same time, these states represent the pillars of a conceptual model that redefines the security environment of the Black Sea specific to the transition period between the “bipolar paradigm of the Cold War” and that of the “frozen security after the end of the Cold War”. The framework of mutual cooperation that, after 1990, formed the security system of the Black Sea was undermined by these egocentric manifestations specific to a “childhood of capitalism” as well as to a world in transition. These negative manifestations delayed the development of the region and, at the same time, abundantly fueled the anxiety of Western states regarding their desire to expand their sphere of influence in Eastern Europe.



Figure 2 Participation of the Romanian delegation in the signing of the official act of dissolution of the Warsaw Treaty. Prague, 1st of July 1991. Source: Agerpress

Over the course of twenty years, three specific security paradigms have influenced regional order. The first of them is known as the “Cold War security paradigm”. It emerged in 1945-1946. Although we cannot make an exact definition of its appearance, we nevertheless consider that a landmark element could be Winston Churchill's famous speech at Fulton, when he referred extremely plastically to the fall of an iron curtain over Europe. It would have been possible, however, that the end of the paradigm occurred at the time of the meeting between Mikhail Gorbachev and George Bush in Malta, in early December

1989. There would be two other possible moments to which we could link the end of this paradigm, and these would be the fall of the Berlin Wall in 1989, or, why not, the dissolution of the Warsaw Pact. The latter version seems to us the most probable because it symbolizes the effective dissolution of a relationship between two military forces, the main pillars that were the basis of the Cold War. With the disappearance of the conflict, the paradigm that defined it also disappeared.



Figure 3 The new states issued after the dissolution of former Soviet Republics, parts of USSR: 1. Armenia; 2. Azerbaidjan; 3. Belarus; 4. Estonia; 5. Georgia; 6. Kazakhstan; 7. Kîrgîzstan; 8. Letonia; 9. Lituania; 10. Republica Moldova; 11. Rusia; 12. Tadjikistan; 13. Turkmenistan; 14. Ucraina; 15. Uzbekistan. Source: Wikimedia

The paradigm of "frozen security" was the successor to that of the Cold War. Its main characteristic is the lack of cooperation, which is based on a whole series of elements that accompanied the period of conflict between the two great powers. This period is one of transition between two paradigms, the next of which can be considered one of cooperation between states. At the same time, it is a landmark on the path to capitalism and the market economy of the former communist states and coincides, as chronological landmarks, with the period of unipolarity that occurred after the loss of Russia's geostrategic, political, military and economic supremacy, following the collapse of the USSR.

One of the greatest challenges to Romania's national security at the end of the Cold War was the fragmentation of state unity in the region. The entities belonging to the former Soviet space triggered a secessionist process, as a result of the strong surges of nationalism resulting from the dissolution of the ideological shell. This, during the Soviet period, proved to be the ideological binder that held the union republics together. The irrepressible desire of nationalists in Chechnya, Nagorno Karabakh, Georgia, as well as in the other republics, confirms, if necessary, the reorientation of each of these entities towards their civilizations of origin.

In the new environment corresponding to the frozen security paradigm, the core and foundation of the Cold War were replaced by the pillars of a new conceptual construction. The concept of deterrence was replaced by suspicion. The states in the region have always feared Russia's military power, but at the same time, they expressed real fears towards each other. The confrontation between ideologies was replaced by the existential problems of regional actors. The former union republics tried, in contact with the European powers, to Westernize their policies, but they remained largely dependent on Russia's energy resources. Although Romania and Bulgaria were confronted with the same economic problems, they knew better than other states how to manage their opening to the West. Romania, for example, has always shown obvious bitterness towards Russia, as the legal heir of the former USSR. A large majority of civil society unequivocally expressed its fully justified desire for Romania to be fully aligned with the values of Western society, in the midst of which it belongs. For many Romanians, Russia after the USSR continued to represent the hereditary enemy.

Currently, the greatest danger to the states of the region is Russia, the threat being accentuated by the Kremlin's insatiable appetite for new territories, and the current aggression against Ukraine does nothing but amplify Putin's speech at one of his annual conferences, in which he specified extremely clearly that "Russia has no borders, it only has horizons". "Russia is itself a boundless universe", and even more than that, stating bluntly that "Russia is the Universe itself, it does not need anyone". ⁶

[6] Reference: <https://hotnews.ro/noua-politica-externa-a-rusiei-putin-rusia-nu-are-granite-doar-orizonturi-73057>

Theology and Spirituality

The Theme of Suffering in St. Gregory of Nazianzus's Poetry

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Abstract: When we refer to St. Gregory of Nazianzus, we think in particular of his theological writings for which he was named „The Theologian”, of his fight in the defense of Christian Orthodoxy against the heresies of his time. In this perspective we see „the saint”. Gregory, as a common person, however, a complicated character, unveils himself in his poetry in a different way than we are accustomed to thinking of him; in this posture he is much less known to the public.

Poetry is the place where we identify his inner life, his way to sainthood, meaning the man with his struggles, doubts, weaknesses, sufferings, temptations, problems, frustrations, indignations, depressions, faults, failures, discontents and complaints.

Keywords: Gregory of Nazianzus, illness, flesh, spirit, solitude, Christ, salvation.

Introduction

St. Gregory of Nazianzus (329-390) was a personality of first rank in the complex world of the fourth Christian century.⁷ John McGuckin believes that St. Gregory was the greatest rhetor of his time,⁸ whereas A. Benoit calls him one of the greatest rhetors that ever existed⁹ and one of the literary giants of the Church¹⁰ with a special vocation for poetry.

Excelling in the fields of theology, philosophy, and literature, as one of the most remarkable intellectuals of his century, St. Gregory was well known for the depths of his

⁷ Michele Pellegrino, *La Poesia de S. Gregorio Nazianzeno*, Societa editrice „Vita e pensiero”, Milano, 1932, p. 107.

⁸ John McGuckin, „Preface” in *Saint Gregory Nazianzen: Selected Poems*, SLG Press, Convent of the Incarnation, Faircross, Oxford, Third impression, 1995, p. VIII.

⁹ Alphonse Benoit, *Saint Gregoire de Nazianze*, Typographie Marius Olive, Marseille, 1876, p. 715.

¹⁰ John McGuckin, *op. cit.*, p. V.

knowledge and for the subtlety of his philosophical and theological interpretations. He was admired but also envied by his contemporaries. His poetic production was immense; towards the end of his life, in particular, he wrote over 400 poems of autobiography, theology, and history, nearly 20,000 verses - 30,000, according to other sources.¹¹

Gregory as a Common Person

When referring to St. Gregory of Nazianzus, we think in particular of his theological writings, for which he was named „The Theologian”, of his fight in the defense of Christian Orthodoxy against the heresies of his time. In this perspective we are seeing „the saint”, Gregory, as a common person, however, a complicated character (as Brian Matz notices¹²), unveils himself in his poetry in a different way than we are accustomed to thinking of him; and this aspect of him is much less known to the public.¹³

Poetry is where we can see his inner life, his way to sainthood, that is, the man in his struggles, doubts, weaknesses, sufferings, temptations, problems, frustrations, indignations, depressions, faults, failures, discontents and complaints.

As John McGuckin comments, St. Gregory’s poetry shows a man aware of his failures and shortcomings.¹⁴ As such, he wrote poetry, among other reasons, based on an inner need for personal consolation in moments when he suffered physical pain, as he himself testifies, but also when he was overwhelmed by sadness at the thought that “an old swan” as he was, would soon have to leave this life.¹⁵

St. Gregory is writing about himself with an overflowing sincerity, openly, as if to someone who knows him in all aspects and details of his life, and from whom he cannot hide anything. However, it is easy to assume that, in the Saint’s mind, God himself was that “someone”. That is why his poetry is a type of confession and at the same time a dialogue with God. However, it is also clear that his poetical laments were meant to be left to posterity. As such, it is a kind of kenosis, of public repentance, and he is showing courage in his overwhelming sincerity, as if saying: this is me, just the way you see me, and what you don't see, I will tell you. The great theologian shows us a total assumption of his physical and spiritual states. That is why in the poem *On his troubles* he can write with surprising detachment: “I will expose my misery in front of all.”¹⁶

With a visible Platonic influence - according to which there is a total difference

¹¹ Theodor Damian, *Gregory of Nazianzus. Discovering a New Face of His Personality*, Cambridge Scholars Publishing, Newcastle upon Tyne, UK, 2022, p. 3.

¹² Brian Matz, *Gregory of Nazianzus*, Baker Academic, Gd. Rapids, MI, 2016, p. 4.

¹³ Theodor Damian, *op. cit.*, p. 63.

¹⁴ John McGuckin, *op. cit.*, p. VI.

¹⁵ Theodor Damian, *op. cit.*, p. 27.

¹⁶ Saint Grégoire de Nazianze, *Oeuvres Poétiques. Poèmes Personnels*, II, 1, 1-11, text traduit et annoté par Jean Bernardi, Les Belles Lettres, Paris, 2004, p. 9.

between body and soul as far as their nature is concerned, and based on which the body, being inferior to the soul, is considered negatively, evil, and a jail for the soul, St. Gregory has a constant tendency to culpabilize the body (the term most often used is actually “flesh”) and its senses for the many mistakes one makes, which in turn lead to the numerous problems one suffers in life. Of a delicate physical constitution, constantly ill, which marked his life profoundly, he argues often with his own “flesh” that he blames and reprimands, as, for instance, when he complains about the unhappy soul dressed in flesh, the “dense flesh” of the present human condition.¹⁷

In the poem *Against the flesh*, as in other poems, too, Gregory discusses the paradoxical union between body and soul and indicates clearly that human dignity is linked to the soul, even if the human “I” is both body and soul, at the same time. That is why, as if chastising the body, he asks decidedly: “Body, respect me, control your desires and stop exerting your fury on my soul.”¹⁸ The hard fight with the bodily drives, not easy at all, is evident from the epithets he uses in a different address: “Flesh, I am telling you, you are so difficult to heal, sweet enemy..., ferocious animal..., fire that cools - incredible thing. Yet, it would be even more incredible if you would end up becoming my friend.”¹⁹

However, in all his troubles and sufferings, physical and psychic, Gregory always turns to Christ and places his hope in Him.

Solitude

The great theologian of the 4th century liked to live a solitary life. He had an undeniable passion for philosophy, which for him meant withdrawal in solitude in order to contemplate the beauty of all things divine. In a letter to his friend Theodore of Tyana, Gregory, while explaining his withdrawal from the world in order to philosophize in peace, the most profitable thing of all, as he puts it, complains that his health had not improved, and asks Theodore to pray for him.²⁰

St. Gregory was made for a hermit lifestyle; he lived ascetically. Solitude was in his heart and mind. One could think that this was not a proper environment for his shaky condition, yet, it is what he considered the most appropriate place in order to complain to God of all his pains. And the greater the suffering, even among protests, the greater his attachment to God. He was living the experience of the desert even while living in the world. It seemed as if the illness would make his longing for solitude stronger. Even when

¹⁷ Theodor Damian, *op. cit.*, p. 59.

¹⁸ *Saint Grégoire de Nazianze, Poèmes et Lettres*, Textes choisis et présentés par Edmond Devolder dans la traduction de Paul Gallay, Les Editions du Soleil Levant, Namur, Belgique, 1960, p. 57.

¹⁹ *Ibidem*, pp. 77-79.

²⁰ Brian E. Daley, S.J., *Gregory of Nazianzus*, Routledge, London and New York, 2006, p. 203, note 180.

he was younger, in his prime, these two, illness and the longing for solitude, asceticism, were obvious in his physiognomy and in his life. One can see that even in the complaint about his appointment as bishop of Sasima, a hamlet he calls a “pit hole”, when he writes this deplorable self-portrait: “a man who has nothing, wrinkled, crooked, poorly dressed, melted by fasting and tears, with an undignifying face.”²¹

Even when he was patriarch of Constantinople during the Second Ecumenical Council, which he led in part, the state of his health was not good and the desire to withdraw into seclusion incessant. In 381, after the problems he had to go through during the debates of this council, he resigned in order to retreat to Nazianzus, on the family's estate, yet in isolation, in order to dedicate himself to prayer, meditation, and poetry, where he found consolation. In his farewell speech departing from Constantinople, he invoked as the reason for his resignation the condition of his health. He describes himself, while deploring his physical state, degraded by time, illness, and work, as being an old man, shy, dying every day, tired physically and mentally, so much so that he could barely speak.²² He left the imperial capital telling those he left behind that he owed nothing to anybody putting it in this way: “the only debt I have to pay is death, and this belongs to God.”²³

Health problems

As time passed, several diseases found their place in Gregory's body. Around the year of 368, a terrible infection appeared in his mouth, reaching to the end of the throat and preventing his normal breathing. At times he could not breathe at all, making him think that he lived his last days. Then he was hit by asthma that tormented him for the rest of his life.²⁴ After 380, his health deteriorated further. Now he was having problems with his legs. The care offered by several doctors was of little help.²⁵

John McGuckin mentions an acute rheumatism that around the years 382, 383 debilitated him even more. That determined Gregory to go to the Xanxaris baths, near Tyana (in Cappadocia), for treatment,²⁶ which did not help much, however.

Stelianos Papadopoulos describes how a horrible arthritis tormented him awfully. Gregory could barely move his legs, could not bend them any more, thus forcing him to write daily while standing. Yet what hurt him the most was that he could not kneel

²¹ Jean Bernardi, *op. cit.*, p. 86.

²² Brian E. Daley, *op. cit.*, p. 150.

²³ Jean Bernardi, *op. cit.*, p. 132.

²⁴ Stelianos Papadopoulos, *Vulturul rănit. Viața Sfântului Grigorie Teologul [The Wounded Eagle. The Life of St. Gregory the Theologian]*, Translation from Greek by Constantin Coman and Cornel Bizantină, Bucharest, 2006, p. 73.

²⁵ *Ibidem*, p. 275.

²⁶ John McGuckin, *Saint Gregory of Nazianzus: An Intellectual Biography*, St. Vladimir's Seminary Press, Crestwood, New York, 2001, pp. 387-388.

anymore for prayers.²⁷ Around the year 387, Papadopoulos specifies in his book *The Wounded Eagle*, asthma and arthritis were simply torturing Gregory, and the stiffness of the body caused him unbearable pains.²⁸ In the following years those pains increased further, he became weak, felt more and more cold, was just skin and bone. The doctors who came to see him were completely powerless. His body wasted away, and the asthma cut off his breathing.²⁹ In 390 Gregory became bedridden. He could not bear the pains anymore and could not control his groanings and sighs. This is how St. Gregory the Theologian died in the second half of the month of January 390.³⁰

The Lamentations

Nowhere can one find more details about St. Gregory of Nazianzus's sufferings and especially about the way in which he was bearing them than in his poetry. His poems are full of lamentations, complaints, one can even say whining in the proper sense of expressions of self pity, accompanied by moaning and sighs.

Thus, poetry is the place where one sees the theologian as crying, victimizing and underestimating himself, protesting, showing regret and unhappiness through a large variety of expressions, one more impressive than the other. Here are some of them: "my pains," "my sufferings," "my illnesses," "my failures," "my miseries," "my tortures," "my burdens," "my wounds," "a groaning heart," "my dead limbs," "sad life," "I am tormented over here," "fragile old age," and others. Some lamentations also indicate a state of harsh self-judgment with accents of repentance, as for example, when he bitterly culpabilizes himself: "I am bad" "cry, cry, sinner," "the serpent caught me again," "I am terrified."³¹

Repenting for "my bitter mistakes," he addresses himself: "Oh, unhappy me! Oh, soul that suffers sad punishments!" In many other places Gregory talks to himself, moaning in desolation and bitterness: "All that is left in me is a hopeless pain. This is what makes me groan." However, a glimmer of hope is visible from the way he speaks about purification of all his "filths" through rivers of tears, weeping to match his mistakes (*On his troubles*).³²

Then, with analogies to the Gospels, he describes himself: "I am a new Lazarus among the dead," "I am a new paralytic lying in bed," "This is my pain and the illness that overtakes my limbs," and again: "an ugly illness devours and destroys me, weakening my

²⁷ Stelianos Papadopoulos, *op. cit.*, p. 291.

²⁸ *Ibidem*, p. 297.

²⁹ *Ibid.*, p. 306.

³⁰ *Ibid.*, pp. 314 și 322.

³¹ Theodor Damian, *op. cit.*, p. 106.

³² Jean Bernardi, *op. cit.*, pp. 32, 18, 21, 22, 25, 38.

limbs every year” (*Against the deceiver in time of sickness*).³³ In the poem *To himself in form of question and answer*, the suffering Saint asks and responds: “Where is the strength of my well-made limbs? Exhausted by sickness.” And then, as if taken by despair: “Where should I throw my body?” In the poem *Lamentation* he even asks Lord Jesus, somehow as if reproaching, yet as if waiting for a confirmation related to this tormented destiny, and as if this confirmation would have brought a certain consolation: “Alas, alas, my sufferings! What did I do wrong? Am I the only one who treated improperly your pure sacrifices?” And then he continues complaining about temptations, just as a child does when he runs to his parent, seeking protection: “Alas, my Christ, the serpent came to me again...” and then, crying out, using a metaphor: “Sword, extinguish the cursed fire at least a little” (*Lament to Christ*).³⁴

Speaking about his tormented old age, Gregory confesses his powerlessness and also his disagreement with what is happening to him, even though with some kind of resignation: “Old age has poured on me its embarrassing ordeal; I bend to the ground, multiplying the sadness in my heart” (*On his troubles*).³⁵ In another poem he describes his weakness but also the permanent fight with the flesh: “Old age advances, my limbs are weak, yet the rebellious flesh continues to make its madness felt” (*Elegy*). And in the poem *Lamentation*, announcing again the suffering, he writes: “I am wounded by many evils and bodily pains,” which causes him to actually weep: “Alas, alas, my tears are flowing,” he addresses Christ the Saviour, telling Him that he gave up a sin and consequently Jesus should take away his pain: “My pride is gone; you make the pain of my flesh go as well.”³⁶

Impressive and very touching is also the moment when the Saint from Nazianzus describes the depth of his passion in his old age: “Already my hair is white and my articulations contract...,” “I have started already to get closer to the evening of a painful existence...,” “I have never had such a profound pain” (*On his troubles*).³⁷ He seems shaken, becomes skeptical, interrogative, with a penchant to nihilistic evaluations: “Nothing is sure. I am, indeed, a murky stream of a river, always passing, having nothing stable,” “I am nothing. Why am I hit by so many evils?” (*On human nature*).³⁸ In other words, if he were “somebody,” he could understand the reason for the blow or even for the devil’s temptations. Yet, being a “nothing,” the question would be: why?

³³ St. Gregory of Nazianzus, *Poems on Scripture*, Transl. and Introduction by Brian Dunkle, St. Vladimir’s Seminary Press, Yonkers, New York, 2021, pp. 143, 145, 141.

³⁴ *Ibidem*, pp. 137, 129, 157.

³⁵ Jean Bernardi, *op. cit.*, p. 26.

³⁶ Brian Dunkle, *op. cit.*, p. 131.

³⁷ Jean Bernardi, *op. cit.*, p. 22.

³⁸ *On God and Man. The Theological Poetry of St. Gregory of Nazianzus*, Translated and introduced by Peter Gilbert, St. Vladimir’s Seminary Press, Crestwood, New York, 2001, p. 133.

After having such thoughts, he exclaims, as if being at the end of his power, yet also on a slightly nihilistic note, as if nothing is important, nothing counts anymore: “I have enough of all that the present can offer: wealth, poverty, joys and unjoyful things, honor, humility, enemies and friends.”³⁹

In the poem *Prayer to Christ*, speaking bluntly of the “life of suffering” and of “my poor body,” as he always does after lamentations, even after those that seem to be formulated in the negative, Gregory turns to Christ, his unmoved anchor: “Look to my poor body,” he tells Him, “Your own making, created with Your own hands. Now the time has come that I leave it; how pitiful it is, how badly it smells, how terribly fragile it has become.” Then the request comes: “Help me or take me out of this life before the end will bring me ever greater pains.” As if he had suffered enough, Gregory comes with his interesting logic meant to persuade Christ to bring his life to an end: “Lord, why is there a need for more pains in order to purify my soul?” The question is courageous, because it implies the idea that the pain he endures is sufficient and he feels he is already pure.

St. Gregory continues to lament, yet on a different tone, now expressing his faithfulness and adhesion to Christ: “I die, I die in these big tribulations; however, I am dying for You, my God, the one who disperses the darkness of sickness for this dead man, who just for a little more time, lives in this painful life.”⁴⁰

The reproaches

In order to better understand St. Gregory's troubled spiritual state that at times could bring him to the brink of despair; one needs, besides the few mentioned instances where the dialogue with Christ seems to be disrespectful, to get into more detail into his addresses to Lord Jesus, in particular those that indicate in more expressive ways, due to the dire suffering, his indignation, reproach, warning, order, even ultimatum.

Thus, in many places in his poetry, the great theologian seems to allow himself to be overwhelmed by dark thoughts, feeling abandoned by God, even though in the same moments he continues to have strong faith in Christ as his Savior. This situation is similar to the one when Christ, on the cross, on the one hand, cried to the Father: “Why did you abandon me?”, yet on the other hand, at the same time, He manifested His uninterrupted connection with the Father when He said: “In Your hands I entrust My soul.”

Gregory writes: “I fought bitterly, and I chased Satan away. Yet You, Lord, did not come to fill me, and inside me did not blow the grace of your Spirit... why are you scolding

³⁹ Brian Dunkle, *op. cit.*, p. 133.

⁴⁰ John McGuckin, „Preface”, pp. 17-18.

me, why did you abandon me...? Do with me the way You want.”⁴¹ The idea of abandon appears also in guise of a conclusion: “I weep because Christ has abandoned me, He who used to take care of me” (*Against the deceiver in time of sickness*), yet continuing to keep Christ accountable in other ways: “If I am God’s breath, why, Christ, allow that I be bound to the earth?” (*Elegiac*); “why do the believers have problems and the sinners don’t? (*Lamentations about his pains and a prayer to Christ to take him from this life*).

About the end of life, this is what the Theologian from Nazianzus writes in the poem *Desire for death*: “If I am nothing, my Christ, why did You make me so? If You cherish me, why am I assaulted by so many evils?”⁴² One has to notice here St. Gregory's courage to reproach to Christ the Savior his problems and existential dilemmas.

In the poem *Imploration* there is another reproach to the Lord, in the context of the “sickness's fury,” specifying that his knees don’t obey him anymore, that his limbs lost their power, that illness and time have finished him: “Lord Christ, why did You bind me in this trap of the flesh, in this cold life, in this muddy and miserable hole, if I am, as one would say, Your inheritance, indeed divine?” Then follows a strange combination of prayer and warning: “Have mercy, put an end to this misery, or decide that I have fought enough and have me taken away from here, put an end to my sufferings.”⁴³

In another poem (*Lamentation*) one reads the same type of ultimatum, even though phrased slightly differently: “You either stop the evil and have mercy on Your servant, or allow this unfortunate soul to endure everything.” This imperative attitude is manifested also in the context of some questions through which the Saint wants to hold Christ accountable: “Did You turn off Your grace towards Your servant?”, as if telling Christ: while others still receive it? And also: “Why has Your servant been ruined?”, a question sweetened by its introduction: “Give me strength, my Christ” (*The prayer of a sick man to Christ*), and completed by a declaration of faithfulness: “If I ever betrayed You during the tempest, then You can throw me again” (away from your face),⁴⁴ implying that he never betrayed Jesus. Yet, in his mind the question seems to persist: why is all this happening to him?

Continuing in the same tone, Gregory manifests indignation for his illness, for the problems of his life, and, with the same courage that could seem out of place, he questions Jesus: “Why am I so much hit by the waves of life?” And then, as a possible, indirect accusation: “Had I not been Yours, my Christ, this life would be a crime.”⁴⁵

Notwithstanding all these reprimands, however, St. Gregory realizes what could be considered his “insolence,” guts or impiety of holding Christ responsible for what he has

⁴¹ Stelianos Papadopoulos, *op. cit.*, p. 301.

⁴² Brian Dunkle, *op. cit.*, pp. 141, 131, 135, 133.

⁴³ Brian E. Daley, *op. cit.*, p. 171.

⁴⁴ Brian Dunkle, *op. cit.*, pp. 131, 125.

⁴⁵ Brian E. Daley, *op. cit.*, p. 170.

to do in life or how he must be treated. Here is a surprising and welcome declaration: “This is something extraordinary for me to make laws for divinity. O Christ, do with me, Your servant, the way You want” (*Against the deceiver in time of sickness*).⁴⁶

All the above references to reproaches and questions offer us the most adequate chance to imagine the terrible, unbearable pains, maybe even the coming to the limits of despair in some moments of excruciating and indescribable suffering in the life of the Saint.

Yet, it is important to point to the fact that even in such moments he was clinging to Christ “as a child to the mother’s lap,” as nicely put by a Romanian poet.

Christ, the last refuge

Towards the end of his existence, having enough of pains, of life itself, St. Gregory of Nazianzus asks Christ to bring an end to his sufferings.⁴⁷ “Through Your death [O, Logos], liberate me from this life. Give me rest in my trouble” (*Lamentations about his pains and a prayer to Christ to take him from this life*).⁴⁸

The Saint's insistence indicates the unbearable state in which he was: “Come,” he prays Christ, “help Your servant, and don't send a gloomy end to my life;” then, with a certain type of courage combined with prayer, he writes: “If You hid Yourself from me, give me strength for help in the battle” (*Against the deceiver in time of sickness*). And again: “What kind of relief will I have in my troubles? O, Christ, my king, save me!” (*Lamentation concerning the sorrows of his soul*). At times, Gregory speaks as if Jesus were a common person, who can forget things or who could be taken by surprise: “Lord, don't forget me, lest the enemy wrest me when You will not notice” (*Request to Christ*). In the attempt to convince Christ, in the poem *Lamentation*, St. Gregory invokes the gift of priesthood in the hope that this could be a leverage in front of God in order to obtain preferential grace or treatment: “Give me strength,” he prays, “even if I am a sinner (yet still a priest!)”⁴⁹

The Saint’s fight with the devil is heartbreaking. He is at the end of his energy. His prayer to Lord Jesus is of profound fondness: “See me, my Christ! Satan finished me. For how long should I still endure? He held me with the petrification of my body, he poked me with the asthma ... I am like a dry tree with frail roots in the blows of the wind. Come, therefore, again, my Christ, and give me Your light so I can go through the torments that have come over me.”⁵⁰

⁴⁶ Brian Dunkle, *op. cit.*, p. 147.

⁴⁷ John McGuckin, „Preface”, p. VI.

⁴⁸ Brian Dunkle, *op. cit.*, p. 135.

⁴⁹ *Ibidem*, pp. 147, 151, 157, 131.

⁵⁰ Stelianos Papadopoulos, *op. cit.*, p. 300.

In many cases, the increased prayers to Christ, but also their tone indicate urgency. The Saint cannot wait anymore, has no more patience. In fact, he acknowledges that when he writes: “I am not an athlete of patience.”⁵¹ Yet from all his addresses one can see his sure, unquestionable, profound feeling that the Lord Jesus represents his last refuge, the anchor of his unshakeable hope, just as we read in this poem: “O Christ, God, You are my homeland, my strength, my richness, my fullness” (*To himself in form of question and answer*).⁵²

The consolation

In his old age, towards the end of his life, in those years of pain, suffering, and isolation, St. Gregory finds consolation in two main directions: his past and God. As far as the past is concerned, he finds comfort in thinking not of the old griefs but of his life marked by joy and accomplishments, of the talents, gifts, successes, glory, and admiration that he experienced. One can see in this context an awareness on his part of the meaning of his life, a conscientization of the human dignity which is not incompatible in any way with the humiliations that came from other people or that were caused by the illness that he had to go through. Thus, he remembers fondly his former parishioners who admired and loved him so much: “Those who sometimes enjoyed our sermons,” he writes (*Against the deceiver in time of sickness*) with a justified “humble pride” that confirms his preaching vocation. Also, remembering the administrative ecclesiastical position that he had and which placed him at the top of his society on personal and professional levels, brought him similar comfort, even if he writes about them as if having some kind of regret: “I am not sitting in the company of the victorious ones any more” (*Against the deceiver in time of sickness*).⁵³

But in his suffering, Gregory finds consolation in the idea that everything is part of God’s order: “I wonder about my old age and of my crippled limbs and about the sacrifices I suffer in my pains sent from heaven” (*Against the deceiver in time of sickness*).⁵⁴

It is with this kind of understanding that in his longest poem, *De vita sua*, he speaks of “blessed wounds,” and when he writes an epitaph for his friend Philagrios, ill and in pain on his deathbed, St. Gregory calls the illness “healing suffering.”⁵⁵

The thought of Jesus Christ’s suffering on the cross, yet of the glory of the resurrection that followed, brings a different kind of consolation as well. Assuming Christ’s crucifixion

⁵¹ *Ibidem*, p. 202.

⁵² Brian Dunkle, *op. cit.*, p. 139.

⁵³ *Ibidem*, pp. 141, 143.

⁵⁴ *Ibid.*, p. 147.

⁵⁵ John McGuckin, „Preface”, p. 18.

in his own suffering, Gregory declares with no hesitation: “I bear a cross in my limbs, a cross on my way, a cross in my heart. This cross is my glory” (*Repelling the devil and invocation to Christ*). One can see here a type of resignation in the face of death, a serene acceptance of the end due to a sentiment of dignified satisfaction at the thought that in the fight with the devil he prevailed definitively. This is how he talks to the devil: “Never did I bend the knee of my heart to you, but invincible and unconquered I will descend into the mother earth.” And this is how he will meet Christ the Lord: “I will present to Christ the divine image that I received” (*Against the deceiver in time of sickness*).⁵⁶

Thus, just as one can see also in a very long poem, *On his troubles*, in particular towards the end, where the theologian enumerates, as in an inventory, all his worries, turmoil, and complaints, the thought goes toward God in whom he places all hope and whom he invokes under several theological names, as in a kind of doxological address meant to attract the divine mercy. And even if, in general, he describes negatively the human nature concerning the physical aspect, in final analysis he finds reasons to be convinced that everything has a sense and that God did not abandon the creation of His hands. In the poem *On human nature* the theologian becomes philosopher, writing as in a supreme consolation, for himself, yet for others too: “Stop. Everything is secondary to God. Listen to your reason. God did not make me in vain.”⁵⁷ Thus he feels relieved, spiritually set free, and can confess: “My poor soul aspires to see, finally, the day of its liberation,” as he begins his journey to what he calls “the divine homeland.”⁵⁸

Conclusions

St. Gregory of Nazianzus was a fascinating personality. In a way, as walking on the traces of Lord Jesus Christ, he was at once weak and strong, sarcastic, where necessary and uncompromising with his enemies, yet of a kind and loving nature. He experienced conflicts, dilemmas, and went through extreme situations, yet always with a stoic patience.

Indeed, his poetry unveils the real human being. It is an instrument of great significance for a necessary and objective knowledge we want and must have about the Saint, who was a redoubtable theologian, a bright philosopher, an unsurpassed orator, a Christian poet of most authentic vocation, considered by some biographers the poet *par excellence* of Eastern Christianity,⁵⁹ and an ascetic of high moral class, who dedicated his entire life to God totally and irrevocably.

⁵⁶ Brian Dunkle, *op. cit.*, pp. 155, 143.

⁵⁷ Peter Gilbert, *op. cit.*, p. 136.

⁵⁸ Jean Bernardi, *op. cit.*, pp. 24-25.

⁵⁹ *Catholic Encyclopedia*, vol. VII, „Gregory of Nazianzus”, by K. Knight, updated Oct. 6, 2005, p. 8.

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Lansare carte

Congresul ARA-46, Lafayette, SUA, 28-29 aprilie 2025

ASOCIAȚII SENIORE LA ÎNȚEPRINDERE – MAMĂ: ISTORII DE SUCCES

Autor: Dumitru TODOROI, prof. univ., dr. hab., M. c. ARA



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Cartea cuprinde un ghid pentru inițiatorii și creatorii de Asociații Seniore la Întreprindere – Mamă și câteva istorii de succes de Asociații Seniore din spațiile rurale și urbane ale Republicii Moldova.

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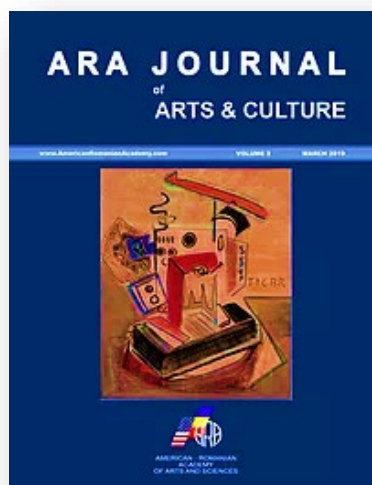
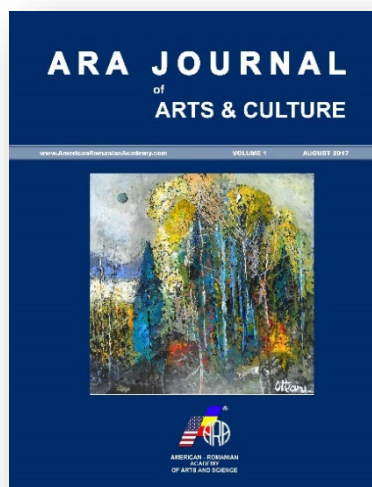
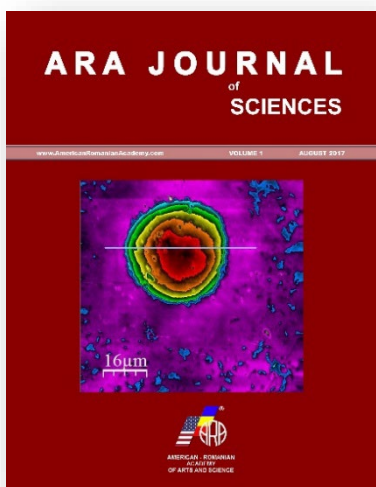
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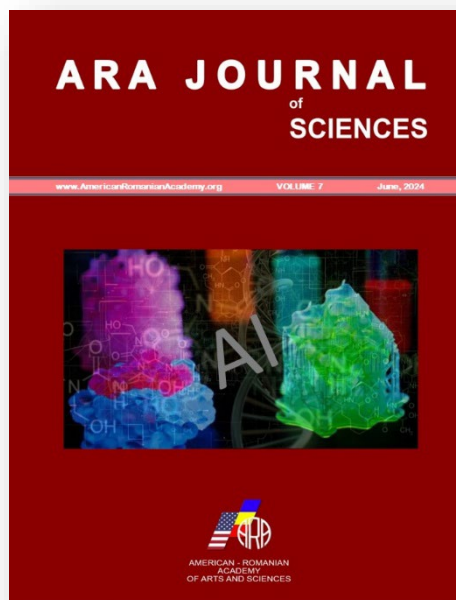
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