Ind. J. Pharm. Edu. Res., 2026; IPC Issue:38-44.
https://www.ijper.org

Original Article

Pharmacological Evaluation of Chrysin Loaded Phytosomes in Treatment of Colorectal Cancer in Wistar Rats

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ABSTRACT

Background: Colorectal Cancer (CRC) is a global health burden, necessitating safer treatments. This study evaluated the anticancer efficacy of Chrysin-Loaded Phytosomes (CLP) in a Wistar rat model induced by 1,2-Dimethylhydrazine (DMH). **Materials and Methods:** CLP was prepared via antisolvent precipitation and characterized for particle size, entrapment efficiency, and crystallinity. Acute oral toxicity followed OECD 423 guidelines. Rats received DMH (i.p.) for 20 weeks to induce CRC, followed by 21 days of treatment with pure chrysin (500 mg/kg) or CLP (100, 200, 400 mg/kg). Parameters included polyp count, colon weight-to-length ratio, liver function, and hematology. **Results:** CLP significantly reduced colon weight-to-length ratio and polyp incidence compared to disease controls ($p<0.05$). Treatment restored liver enzymes and hematological indicators toward normal levels. Histopathology showed improved mucosal architecture and decreased dysplasia, especially at the 400 mg/kg dose. **Conclusion:** CLP demonstrated significant protective effects against CRC, suggesting it is a promising nanoformulation for enhanced therapeutic delivery.

Keywords: Chrysin, Colorectal Cancer, Dimethyl Hydrazine, Nanoformulation, Phytosomes.

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INTRODUCTION

According to data published by GLOBOCAN, CRC is the fourth most common and third most deadly type of cancer worldwide.[1] Because of sedentary ways of living in addition to consuming processed foods with little fiber, The prevalence of CRC is rising in emerging nations.[2] If CRC is discovered at an early stage, chemotherapy can be used as a treatment. However, it has been discovered that these chemotherapy medications have a number of side effects, making the danger outweigh the advantages. It is advised to use alternative medications, such as herbal remedies in the form of pure phytoconstituents or extracted crude drugs, to avoid the side effects of chemotherapy treatments. One phytoconstituent, chysin, belongs to the flavonoid class and is known to have anticancer activities in numerous forms of cancer. It is also known as 5'7 dihydroflavone. Passion flower, propolis and honey are the primary phytoconstituents that contain chysin.[3] Reviews of previously published scientific research have demonstrated that chysin has a superior cytotoxic impact on a variety of CRC cell lines[4] and in *in vivo* tests.[5] One study using Wistar rats demonstrated that the phytoconstituent Cisplatin-induced deterioration of goblet cells within the colonic crypts was significantly attenuated by Chrysin, likely through the amelioration of oxidative stress and apoptosis.[6] It has been showed that the phytoconstituent chrysin is useful in the treatment of CRC.[7] However, investigations have shown that because chysin has a very low bioavailability, a higher dose is needed to treat CRC.[8] A new nanoformulation called phytosomes helps reduce the size of the phytoconstituent, which increases surface area and as a result, enhances permeability.[9] Studies contend that putting a medication into a phytosomal form improves its stability.[10] This work's primary goal is to develop, define and pharmacologically assess the anticancer activity of chrysin-loaded phytosomes in Wistar rats because there are currently no research being done to investigate the phytosomal version of chrysin's possible anticancer properties.

MATERIALS AND METHODS

Preparation of Chrysin-Loaded Phytosomes

Using the antisolvent precipitation method, chrysin-loaded phytosomes were created as previously reported by Kudatarkar *et al.* (2022).[11] Briefly, chrysin and soya lecithin were dissolved and refluxed in dichloromethane followed by precipitation using

DOI: 10.5530/ijper.ipc005

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an antisolvent system. The obtained phytosomal complex was filtered, dried and stored for further *in vivo* evaluation.

Experimental animals

Wistar rats (male) were acclimated in an experiment room with a regulated humidity level of 75%, temperature of 23°C and a cycle of 12:12. In sterile polypropylene cages with sterile rice husk bedding, rats were housed. The animals were given water and food. The study employed male rats that were 8 to 10 weeks old and weighed 190±10 g. The animal study was scrutinized by the experts invited by KLE College of Pharmacy, Belagavi. Care and handling of animals were followed as per CPCSEA guidelines. Institutional Animal Ethics Committee (IAEC) of KLE College of Pharmacy, Belagavi approved protocol, under approval Reg. No. 221/PO/Re/S/2000/CPCSEA.

Oral Acute Toxicity Studies

According to OECD 423 recommendations, acute oral toxicity were conducted. Wistar rats that were 8 weeks old were used. According to OECD 423 standards, the limit test was carried out by giving a 2.g/kg.p.o. dosage to each animal at a time, followed by three animals following a 24 hr pause. For 72 hr, animals were monitored cage side for signs of fatality or any other acute toxicity.

Dimethyl hydrazine (DMH) induced CRC and its therapy with chrysin and chrysin-loaded phytosomes

Rats were distributed randomly based on their body weight. According to the literature, in order to induce CRC in rats, DMH was given to them in doses of 20.mg./kg. i.p. for the first 10.weeks and 30.mg./kg..i.p for the following 10 weeks.[12] After the 20th week.of 1, 2 dimethylhydrazine induction, .rats in the normal control group and disease control group did not received any drug whereas standard group received 5-Fluorouracil (weekly once 10 mg/kg.i.p.). After 20 weeks of receiving DMH, the rats in the fourth group were given 500 mg/kg of pure chrysin orally and 5th, 6th and 7th group received Chrysin Loaded Phytosomes (CLP) with an oral dose of 100, 200 and 400 mg/kg after 20th week of DMH administration for 21 days. The colorectal tissue was examined for polyps, colon weight by length ratio, hematological estimation, biochemical estimation and histological inspection after the rats had been sacrificed.

Number of polyps present

The incidence of Aberrant Crypt Foci (ACF) was measured in each group of rats and expressed as a percentage:

[No of rats with.aberant crypt foci /.No of rats examined] x100

Determination of colon.weight.by length ratio

Colon.weight /.length ratio=weight of colon in gram / length of.colon in cm

Hematological parameters

A retro-orbital puncture was used to remove the blood right before the rats were sacrificed. Blood was drawn into a 2 mL eppendorf tube with 0.5% EDTA anticoagulant. The animal-cell count analyzer determines the hematological parameter. Between the treatment groups, the following variables were compared and a summary was provided: Total RBC count, Hemoglobin content, total WBC count, total platelet count and the percentage of lymphocytes and monocytes.

Biochemical estimation

Estimation of liver enzymes like AST, ALT and ALP was carried out as per standard procedure.[13]

Histopathological examination

For histopathological examination, the samples of colorectum was fixed using neutral formalin solution (10%) using normal saline after which the washing was done in sterilized water.[14] It was washed with alcohol for dehydration of the specimen. Cleaning of the specimen was done with xylene. It was embedded in paraffin at an temperature of 56^{0}C using hot air oven for a full day. Using a sledge microtome sliced paraffin bees wax tissue blocks into 4 m-thick sections. Following deparaffinization and hematoxylin and eosin staining, tissue slices were obtained and placed on glass slides. The material was analyzed for histopathological alterations using an electric light microscope.

Statistical analysis

To examine the data, ANOVA was employed. To assess if there had been any noteworthy variations between the treatment groups, the *post hoc* Tukey's test was employed. At $p<0.05$, the findings were considered significant. The Prism 5.03 Demo Version (GraphPad Software Inc., La Jolla, CA, USA) was used for all statistical analyses.

RESULTS

Oral acute toxicity studies

Toxicology research was done in accordance with OECD 423 regulations. CLP at a dose of 2 g/kg were given orally to rats; no mortality was noted and the animals exhibited no adverse effects. After additional 14-day observation, it was concluded that there was no toxicity because the animals displayed no adverse effects on their immune systems, central neurological systems or peripheral nervous systems. We have chosen 1/5, 1/10 and 1/20 as the therapeutic doses p.o. for animal models based on prior research and non-lethal consequences of our acute toxicity investigations.

Effect of CLP treatment on Polyp count as ACF incidence

The polyps were counted from the indivisual animals of all the groups and are included in Table 1. The findings demonstrated that there was more number of polyps in diseased control group. The number of polyps were reduced in rats administered with chrysin loaded phytosomes.

Effect of CLP treatment on Colon weight/length ratio

In the present study it was found that colon weight/length ratio was increased in DMH group and improvement was seen in standard and CLP group in a dose dependent manner. The colon weight/length was determined and is given in Table 2.

Effect of CLP treatment on Hematological parameters

Comparing the groups hematological data revealed substantial differences, with the DMH control group's RBC level falling below that of normal control group..There was also significant. difference seen that is increased level in standard, chrysin, CLP-I, CLP-III and CLP-III groups when.compared with disease.control group. It indicates that 5-FU, pure chrysin and CLP did not have any destructive effect on red blood cells.

When comparing the DMH control group with normal control group, there was rise in WBC level having significant difference in the case of WBC. There was significant difference seen that is the standard control, pure chrysin group and the three groups of CLP had a reduction in the WBC count when compared with disease control group. Comparing to the control group, the WBC level of the pure chrysin and chrysin-loaded phytosomes differed significantly. CLP-II and CLP-III group showed significant difference with $p<0.05$ compared to pure chrysin group. A significant difference was detected between CLP-II and CLP-III groups ($p<0.05$) compared to CLP-I. Significant differences in platelets were seen in standard control group, pure chrysin, CLP-1, II and III when compared with normal control ($p<0.05$). Platelet levels of standard control group, pure chrysin, CLP-1, II and III increased significantly ($p<0.05$) compared to diseased control. Pure chrysin and CLP-I significantly differed from the conventional control ($p<0.05$). CLP-I, II and III significantly increased platelet levels compared to the pure chrysin group. CLP-III significantly increased platelet levels compared to the CLP-I group. The disease control group had significantly lower hemoglobin levels compared to the normal control group ($p<0.05$). The hemoglobin level elevated significantly in standard control, pure chrysin, CLP-I, CLP-II and CLP-III groups with $p<0.05$ when compared to disease control group. This showed DMH administration reduced the hemoglobin level which might be because of methylation effect of DMH on cells. The hemoglobin level of CLP-III showed significant increase in hemoglobin level compared to pure chrysin group. This may be because of increase permeability of CLP-III in the systemic circulation and protective effect on hemoglobin. The hemoglobin level of CLP-III were increased significantly when compared with CLP-I and CLP-II groups with $p<0.05$. There was significant decrease of monocyte level in disease control group compared to normal control with $p<0.05$. Monocyte level of standard, pure chrysin, CLP-I, CLP-II and CLP-III group increased significantly when compared to disease control group. CLP-III group showed an significant elevation in the monocyte level compared to pure chrysin group and CLP-II group. In case of lymphocyte, there was no significant changes seen between the groups. The lymphocyte counts of all treated wistar rat groups remained comparable to those of the control group, with no statistically significant differences detected, suggesting that the treatment did not measurably affect lymphocyte-mediated immune status under the study conditions. The result of hematological parameters is shown in Table 3.

Effect of CLP treatment on Biochemical parameters

The AST levels in the disease control, standard, pure chrysin, CLP-I, II, and III groups showed significant differences ($p<0.05$) compared to the normal control. When compared to the diseased control, the standard, pure chrysin, CLP-I, II and III group demonstrated a substantial decrease in the AST level ($p<0.05$). Pure chrysin, CLP-I,II,III group displayed significant changes in the AST level when compared with standard control group with $p<0.05$.There was significant decrease seen in CLP-I,CLP-II

Table 1: Number of polyps in the groups.

Group	Number of polyps in each animal						
	1	2	3	4	5	6	Total
Normal control	0	0	0	0	0	0	0
Diseased control	8	6	5	7	8	5	39
Standard control	3	4	4	3	3	4	21
Chrysin	6	5	7	6	4	6	34
CLP-I	6	6	6	4	6	3	31
CLP-II	4	4	5	5	6	4	28
CLP-III	3	5	4	4	5	4	25

and CLP-III group when compared with pure chrysin group. There was also significant decreased AST level seen in CLP-II and CLP-III group when compared to CLP-I group. CLP-III group had significant decrease when compared with CLP-II group. The ALT level showed significant increase in the Diseased control group. .The ALT level displayed that standard, pure chrysin, CLP-I,II,III Significant differences were detected when compared to the normal control group (p<0.05). The standard group, pure chrysin and CLP-I,II,III group showed significant decrease in the ALT level when compared with disease control group. Pure chrysin group showed significant decrease when compared to standard control group. CLP-I, CLP-II and CLP-III group had significant decrease in ALT level when compared with pure chrysin group with p<0.05. CLP-II and CLP-III group had significant decrease in ALT level when compared with pure CLP-I group with p<0.05. When compared to the normal control, the ALP level in diseased control, pure chrysin, CLP-I, CLP-II and CLP-III groups revealed significant variations (p<0.05).Standard, pure chrysin, CLP-I, CLP-II and CLP-III group had significant differences when compared with diseased control group with p<0.05. When compared to the standard control group, the pure chrysin group, CLP-I, CLP-II and CLP-III groups showed significant changes (p<0.05).When compared to the pure chrysin group, the ALP levels in the CLP-I, CLP-II and CLP-III groups decreased significantly (p<0.05). The results of biochemical variables is shown in Table 4.

Table 2: **Result of colon weight/length ratio.**

Treatment group	Colon weight/length ratio
Normal	179.67±2.92
Diseased	636.13±24.39$^{\#}$
Standard	231.65±9.82$^{\#*}$
Chrysin	357.59±5.84$^{\#*\wedge}$
CLP-I	316.60±24.12$^{\#*\wedge\$}$
CLP -II	274.01±10.37$^{\#*\wedge\$a}$
CLP -III	266.06±12.17$^{\#*\wedge\$a}$

#p<0.001 compared to.Normal control, *p<0.05 compared to.disease control, ^p<0.05.compared to standard control, $$p$<0.05. compared to pure chrysin, ^{a}p<0.05 .compared to CLP1, ^{b}p<0.05 .compared to CLP2.

Effect of CLP treatment on histopathological findings of colorectum tissue in DMH treated rats

The findings of the histological examination (Figure 1) revealed that there were inflammatory cells infiltrating the wounded area, which is a sign that the rats had developed cancer. After DMH injection in the current investigation, there was an infiltration of mild to moderately inflammatory cells in the mucosal area. Chronic inflammatory cells, such as eosinophilic cell infiltration and proliferating lymphoid follicles, were scarcely present in the colon mucosa of DMH-induced rats. In rats exposed to DMH, the entire colon was edematous and fibrin deposition was seen. In the colon mucosa and submucosa of the DMH-induced rats, there were haemorrhages, mucosal congestion, desquamation, epithelial necrosis and epithelial ulcers. Furthermore, the mucosal epithelium had hyperplasia and dysplastic alerations. These serve as the physical indicators of the development of adenocarcinoma. As a result, rats were given DMH to produce symptoms of cancer. A 500 mg/kg oral dose of pure chrysin produced findings that were similar to those of rats who had been given DMH. Chrysin-loaded phytosome treatment at oral dosages of 100 mg/kg and 200 mg/kg avoided most of the parameters, including general malignancy condition signs, haemorrhages and eosinophil infiltration, although only mild dysplasia was produced. Treatment with 400 mg/kg of chrysin-loaded phytosomes produced effects that are comparable to those of normal 5-FU.

DISCUSSION

Preclinical *in vivo* testing demonstrated the CLP formulation's safety and effectiveness. Even at a high dose of 2 g/kg, CLP was well-tolerated in rats, according to acute oral toxicity experiments carried out in accordance with OECD 423 criteria. This favorable safety profile informed the selection of therapeutic doses for subsequent efficacy studies. In a DMH-induced CRC model, CLP treatment significantly mitigated disease progression. It effectively reduced the number of polyps and improved the colon weight/length ratio, both critical indicators of anticarcinogenic

Table 3: **Effect of CLP on haematological parameters.**

Groups	RBC	WBC	Platelets	Hemoglobin	Monocyte	Lymphocyte
Normal control	7.77±0.25	7.58±1.95	78.66±3.43	14.43±0.54	08.66±1.36	85.66±1.36
DMH control	6.2±0.86$^{\#}$	12.18±0.05$^{\#}$	28.73±4.86	11.66±0.68$^{\#}$	04.00±0.89$^{\#}$	84.83±1.47
5-FU control	7.35±0.36*	7.8±0.55*	73.33±0.50$^{\#*}$	13.93±0.76*	8.66±3.14*	83.00±4.47
Pure chrysin	7.56±0.34*	12.06±1.72$^{\#\wedge}$	54.93±2.77$^{\#*\wedge}$	13.86±0.88*	8.33±1.03*	81.66±1.36
CLP-I	7.52±0.22*	10.59±0.37$^{\#\wedge}$	64.23±0.85$^{\#*\wedge\$}$	13.96±0.93*	9.66±0.51*	80.66±3.72
CLP-II	8.03±0.24*	8.32±0.95$^{*\$a}$	68.81±2.45$^{\#*\$}$	14.08±0.14*	7.66±1.36*	84.33±2.25
CLP-III	7.96±0.28*	7.95±0.61$^{*\$a}$	73.43±2.52$^{\#*\$a}$	15.66±1.15$^{*\$ab}$	11.50±2.25$^{*\$b}$	84.00±0.89

#p<0.05 .compared to NC, *p<0.05 .compared to DC, ^p<0.05 .compared. to Std, $$p$<0.05..compared to pure chrysin, ^{a}p<0.05..compared to CLP1, ^{b}p<0.05. compared to CLP2.

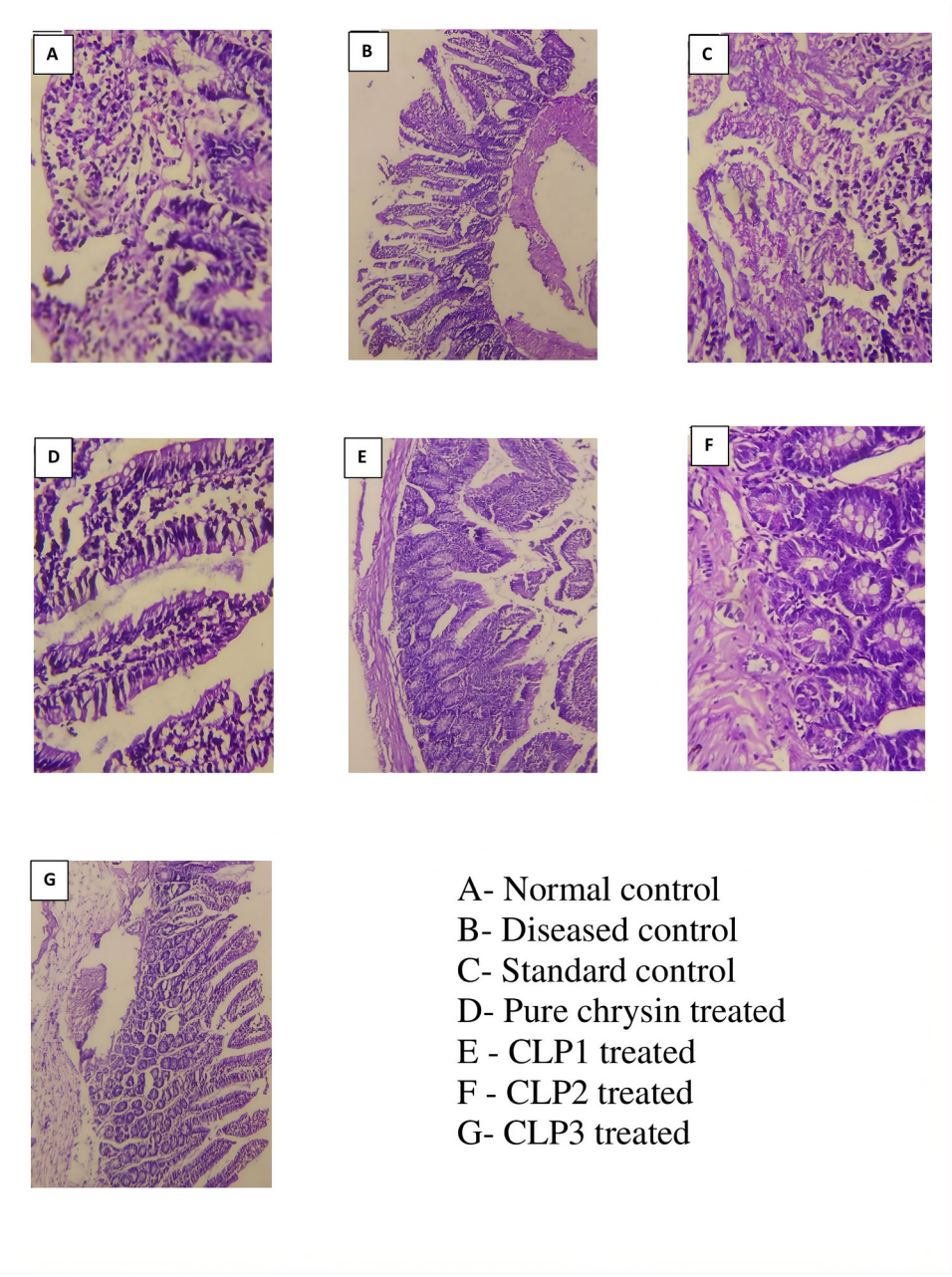


Figure 1: Effect of chrysin and CLP treatment on histopathological findings of colorectum tissue in DMH treated rats.

activity. CLP-III significantly reduced total polyps (from 39 to 25; $p<0.05$) (Table 1) and colon weight/length ratio (636.13±24.39 to 266.06±12.17 mg/cm; $p<0.05$) (Table 2), approaching 5-FU efficacy without myelosuppression. Histopathological examination revealed that Dimethylhydrazine induction produced characteristic features of adenocarcinoma, including inflammatory cell infiltration, edema, necrosis and severe dysplastic changes. However, treatment with CLP, particularly at a dose of 400 mg/kg, markedly ameliorated these pathological alterations and demonstrated protective effects comparable to the standard drug 5-Fluorouracil, with the colon tissue showing only mild dysplasia (Figure 1). This histopathological shift from adenocarcinoma to near-normal mucosa aligns with chrysin's established anticancer mechanisms via apoptosis induction and antioxidant effects previously demonstrated in colon cancer models, enhanced by phytosomal delivery for improved tissue penetration.[14,15] This underscores the potential of CLP as a therapeutic intervention for CRC.

Moreover, CLP treatment positively influenced systemic health indicators. Hematological analysis revealed that DMH administration negatively impacted red blood cell and hemoglobin levels while increasing white blood cell counts (Table 3). CLP, along with pure chrysin and standard treatments, helped to normalize these parameters, suggesting a protective effect on red blood cells and hemoglobin, potentially due to improved

Table 4: Effect of CLP on Biochemical variables.

Groups	AST	ALT	ALP
Normal control	75.26±3.73	27.33±1.36	106±2.94
DMH control	304.66±5.75$^{\#}$	127±8.04$^{\#}$	415.33±6.59$^{\#}$
5-FU control	260.33±3.14$^{\#*}$	98±7.79$^{\#*}$	117.33±9.42*
Pure chrysin	289.33±4.50$^{\#*\wedge}$	115±4.09$^{\#*\wedge}$	311.66±8.99$^{\#*\wedge}$
CLP-I	246.66±1.86$^{\#*\wedge\$}$	97±11.62$^{\#*\$}$	205.33±5.73$^{\#*\wedge\$}$
CLP-II	198.16±2.92$^{\#*\wedge\$a}$	78.66±1.36$^{\#*\wedge\$a}$	186.66±7.58$^{\#*\wedge\$}$
CLP-III	178.33±3.61$^{\#*\wedge\$ab}$	71.66±3.14$^{\#*\wedge\$a}$	132.66±5.73$^{\#*\wedge\$}$

#p<0.05 .compared to NC, *p<0.05 .compared to DC, ^p<0.05 .compared. to Std, $$p$<0.05..compared to pure chrysin, ^{a}p<0.05..compared to CLP1, ^{b}p<0.05. compared to CLP2.

systemic permeability. DMH-induced RBC (6.2±0.86×10^{6}/µL)/ hemoglobin (11.66±0.68 g/dL) reductions reflect bone marrow suppression and hemolytic anemia common in CRC models, which CLP countered via enhanced antioxidant protection of erythropoiesis, achieving near-normal levels (15.66±1.15 g/dL; p<0.05) (Table 3).[16,17] CLP, pure chrysin and standard treatments were able to restore altered blood parameters.[18,19] This indicates they protect red blood cells and hemoglobin, most likely by improving systemic permeability, which helps maintain normal blood function. Similarly, significant improvements were observed in biochemical parameters such which were dysregulated in diseased controls. Elevated AST (304.66±5.75 U/L), ALT (127±8.04 U/L) and ALP (415.33±6.59 U/L) reflect DMH-induced hepatotoxicity; CLP-III restored near-normal levels (178.33±3.61, 71.66±3.14, 132.66±5.73 U/L; p<0.05) (Table 4) respectively via chrysin's established antioxidant and hepatoprotective effects.[20] This indicates that CLP not only demonstrated local therapeutic effects against CRC but also contributed to the overall physiological well-being of the treated animals.

CONCLUSION

The anticancer potential of Chrysin and phytosomes containing Chrysin was investigated in relation to treating CRC caused by DMH in male Wistar rats. Considering the findings in all the parameters with respect to polyps count, colon weight/ length ratio, biochemical tests, hematological parameters and histological examination, when treated with chrysin. loaded phytosomes in a dose-dependent manner, a discernible improvement in the treatment of CRC was observed. Hence, further investigation is required focusing on the clinical aspects of the prepared nanoformulation in the treatment of CRC.

ACKNOWLEDGEMENT

The authors are thankful to KLE College of Pharmacy, Belagavi for providing their laboratory and chemicals for carrying out the research work.

ABBREVIATIONS

CRC: Colorectal cancer; **CLP:** Chrysin-loaded phytosomes; **DMH:** 1,2-Dimethylhydrazine; **ACF:** Aberrant crypt foci; **AST:** Aspartate aminotransferase; **ALT:** Alanine aminotransferase; **ALP:** Alkaline phosphatase; **RBC:** Red blood cells; **WBC:** White blood cells; **5-FU:** 5-Fluorouracil; **OECD:** Organisation for Economic Co-operation and Development; **CPCSEA:** Committee for the Purpose of Control and Supervision of Experiments on Animals.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Namit Kudatarkar- Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Validation, Visualization, Writing - original draft. Sunil Jalalpure- Supervision, Project administration, Resources, Funding acquisition, Writing - review and editing. Aftab Patel- Formal analysis, Data curation, Software, Visualization, Writing - review and editing.

SUMMARY

This study developed a nanoparticle delivery system (phytosomes) for chrysin, a natural compound with anticancer potential but poor absorption. In a rat model of colorectal cancer, these phytosomes significantly reduced tumor markers and restored organ function better than the drug alone, indicating a more effective way to treat colon cancer using nanotechnology.

REFERENCES

1. Rawla P, Sunkara T, Barsouk A. Epidemiology of colorectal cancer: incidence, mortality, survival, and risk factors. Gastroenterol Rev./Przegląd Gastroenterologiczny. 2019;14(2):89-103.
2. Hofseth LJ, Hebert JR, Chanda A, Chen H, Love BL, Pena MM, *et al.* Early-onset colorectal cancer: initial clues and current views. Nat Rev Gastroenterol Hepatol. 2020;17(6):352-64.
3. Kamat S, Kumari M, Sajna KV, Jayabaskaran C. Endophytic fungus, *Chaetomium globosum*, associated with marine green alga, a new source of Chrysin. Sci rep. 2020;10(1):18726.
4. Khoo BY, Chua SL, Balaram P. Apoptotic effects of chrysin in human cancer cell lines. Int J Mol Sci. 2010;11(5):2188-99.

5. Bahadori M, Baharara J, Amini E. Anticancer properties of chrysin on colon cancer cells, *in vitro* and *in vivo* with modulation of Caspase-3,-9, Bax and Sall4. Iran J Biotechnol. 2016;14(3):177.
6. Khan R, Khan AQ, Qamar W, Lateef A, Tahir M, Rehman MU, *et al.* Chrysin protects against cisplatin-induced colon. toxicity via amelioration of oxidative stress and apoptosis: probable role of p38MAPK and p53. Toxicol Appl Pharmacol. 2012;258(3):315-29.
7. Lin YM, Chen CI, Hsiang YP, Hsu YC, Cheng KC, Chien PH, *et al.* Chrysin attenuates cell viability of human colorectal cancer cells through autophagy induction unlike 5-fluorouracil/oxaliplatin. Int J Mol Sci. 2018;19(6):1763.
8. Gao S, Siddiqui N, Etim I, Du T, Zhang Y, Liang D. Developing nutritional component chrysin as a therapeutic agent: Bioavailability and pharmacokinetics consideration, and ADME mechanisms. Biomed Pharmacother. 2021;142:112080.
9. Mukherjee PK, Harwansh RK, Bhattacharyya S. Bioavailability of herbal products: approach toward improved pharmacokinetics. Evidence-based validation of herbal medicine: Elsevier; 2015; 217-45.
10. Maryana W, Rachmawati H, Mudhakir D. Formation of phytosome containing silymarin using thin layer-hydration technique aimed for oral delivery. Mater Today: proc. 2016;3(3):855-66.
11. Chari KY, Polu PR, Shenoy RR. An appraisal of pumpkin seed extract in 1, 2-dimethylhydrazine induced colon cancer in wistar rats. J Toxicol. 2018;2018(1):6086490.
12. Gowda S, Desai PB, Hull VV, Math AA, Vernekar SN, Kulkarni SS. A review on laboratory liver function tests. The Pan Afr Med J. 2009;3:17.
13. Rieger J, Pelckmann L-M, Drewes B. Preservation and processing of intestinal tissue for the assessment of histopathology. Animal Models of Allergic Disease: Methods and Protocols: Springer; 2020; 267-80.
14. Khoo BY, Chua SL, Balaram P. Apoptotic effects of chrysin in human cancer cell lines. Int J Mol Sci. 2010;11(5):2188-99.
15. Lin YM, Chen CI, Hsiang YP, Hsu YC, Cheng KC, Chien PH, *et al.* Chrysin attenuates cell viability of human colorectal cancer cells through autophagy induction unlike 5-fluorouracil/oxaliplatin. Int J Mol Sci. 2018;19(6):1763.
16. Abu O, Okpiabhele A, Akpovona A. Modulatory effects of *Vernonia amygdalina* leaf extract on hematological parameters in rats exposed to 1,2-dimethylhydrazine-induced toxicity. Trends Pharmacol Toxicol. 2025;1(1):12-18.
17. Thangaraj K, Natesan K, Palani M, Vaiyapuri M. Orientin, a flavanoid, mitigates 1,2-dimethylhydrazine-induced colorectal lesions in Wistar rats fed a high-fat diet. Toxicol Rep. 2018;5:977-87.
18. Borawska M, Markiewicz-Żukowska R, Sawicka D, Naliwajko S, Socha K, Omeljaniuk W, *et al.* Effects of chrysin on haematological parameters in rats. Farmacia. 2014;62:390-99.
19. Zeinali M, Meybodi NT, Rezaee SA, Rafatpanah H, Hosseinzadeh H. Protective effects of chrysin on sub-acute diazinon-induced biochemical, hematological, histopathological alterations, and genotoxicity indices in male BALB/c mice. Drug Chem Toxicol. 2018;41(3):270-80.
20. Talebi M, Talebi M, Farkhondeh T, Simal-Gandara J, Ilgun S, Pourbagher-Shahri AM, *et al.* A review on hepatoprotective effect of chrysin: preclinical implications and molecular cascades came into focus. Curr Diabetes Rev. 2026;22(4):e15733998329724.

Cite this article: Kudatarkar N, Jalalpure S, Patel A. Pharmacological Evaluation of Chrysin Loaded Phytosomes in Treatment of Colorectal Cancer in Wistar Rats. Indian J of Pharmaceutical Education and Research. 2026; IPC Issue:38-44.