International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 09, Issue 06, June 2024,
https://doi.org/10.23958/ijirms/vol09-i06/1903

Original article

Clinical Improvement in Knee Osteoarthritis Patients Supplemented with Nutritional Formula with Botanic Actives & Micronutrients; Supporting Joint Health: A Randomized, Double-Blind, Placebo-Controlled Clinical Study

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Received 28 May 2024; Accepted 15 June 2024; Published 22 June 2024

Abstract

Background and objective: Osteoarthritis (OA) is characterized by the progressive degradation of articular cartilage, bone hypertrophy, subchondral sclerosis, and synovial changes. This study evaluates the efficacy of nutritional formula in repairing damaged cartilage and alleviating knee OA symptoms. ***Methods:*** The clinical trial enrolled 54 participants in a randomized, double-blind, placebo-controlled design, assigning them to a nutritional formula (Test) or Placebo in a 1:1 ratio for 90 days. ***Results:*** The study results showed the efficacy of nutritional formula treatment in alleviating symptoms of knee osteoarthritis. By day 90, significant reductions in pain (66.87%), stiffness (65.22%), and physical function impairment (67.19%) were observed. Notably, the substantial improvements in range of motion (8.85%) were observed, indicating enhanced joint mobility. Moreover, the nutritional formula led to reductions in joint swelling, tenderness, and warmth, along with decreased levels of inflammatory markers such as CRP, IL6, and ESR. Improved quality of life and exhibited excellent tolerability, with relief of more gastrointestinal symptoms reported compared to placebo. Furthermore, a reduction (32.84%) in fatigue levels was observed in the test group. Importantly, experienced adverse events were unrelated to the investigational products, affirming the safety profile of the nutritional formula. ***Conclusion:*** Nutritional formula presents promising analgesic, anti-inflammatory effects and shows potential for cartilage regeneration, offering a viable therapeutic option for managing knee OA. Further investigation is warranted to fully elucidate its mechanisms and optimize its clinical application.

Keywords: ***knee osteoarthritis, anti-inflammatory, cartilage repair, chondrocyte regeneration, glucosamine sulfate.***

Introduction

Osteoarthritis (OA) is a highly prevalent chronic joint disease and a leading cause of nonfatal burden, causing pain, disability, and loss of function. Global trends suggest a 114.5% increase in years lived with disability due to OA from 1990 to 2019. The prevalence of OA in India ranges from 22% to 39% [1,2]. OA is characterized by loss of articular cartilage, hypertrophy of bone margins, subchondral sclerosis, and biochemical and morphological changes of the synovium [3]. Risk factors include age, obesity, female gender,

anatomical characteristics, joint injuries, and muscle weakness [4]. The most affected joint is the knee, followed by the hand and hip [2].

The knee joints have a higher prevalence of OA compared to other joints [5]. The pathophysiological alterations in chronic OA include softening, ulceration, focal disintegration of articular cartilage, and synovial inflammation [6]. Clinical symptoms associated with OA are pain, with or without activity and weight-bearing, stiffness after inactivity, and reduced range of motion [7].

Comprehensive management of OA aims to minimize pain, structure, and function loss, including non-pharmacologic and pharmacologic modalities. Pharmacological interventions include oral and topical analgesics, intra-articular corticosteroids, hyaluronic acid, glutathione, chondroitin, vitamin, mineral, and collagen supplementation, along with non-pharmacological interventions like massage, exercise, weight loss, and occupational therapy [4,8].

The lack of self-healing capacity of articular cartilage makes OA challenging [9]. Conventional treatments focus on symptomatic relief, not cartilage regeneration, and long-term use can lead to adverse events. Newer therapies like biologically derived molecules, stem cell therapy, and tissue engineering are still in the research phase with uncertain clinical outcomes and side effects [10].

Nutraceutical supplements like chondroitin sulfate (CS), glucosamine sulfate (GS), and Methylsulfonylmethane (MSM) have been used to manage OA and relieve symptoms. A systematic review showed that nutraceutical supplements provided moderate and clinically meaningful treatment effects on pain and function in subjects with hand, hip, or knee osteoarthritis. Dietary bioactive combinations in nutraceuticals have been revealed to be impressive in improving clinical symptoms and decreasing inflammatory markers in subjects with OA [10,11].

The use of traditional medications for the treatment of OA is frequently accompanied by inadequate clinical management and severe adverse effects. Nevertheless, phytotherapy has demonstrated promise as a secure and effective approach to arthritis management. Regenerative phytotherapy offers the potential to restore the original structure and function of a joint by repairing and rebuilding damaged or missing tissues [12].

The current study aimed to evaluate the therapeutic efficacy of nutraceutical supplements. A comprehensive trial incorporating real-life clinical outcomes is highly beneficial when incorporating a product containing phytoconstituents for the management of osteoarthritis. The purpose of this clinical study was to evaluate the repair and regeneration of damaged articular cartilage and the effectiveness of nutritional formula in alleviating knee osteoarthritis.

Materials and Methods

The study was randomized, double-blind, and placebo-controlled design. A total of 54 participants were randomly assigned to either the test, which received one nutritional formula capsule, or placebo, which received one placebo capsule. Participants took the assigned capsules twice daily after breakfast and dinner for 90 days, following a 1:1 ratio, as illustrated in Consort Figure 1. Ethical approval was obtained from the Institutional Ethics Committee (IEC) of Lokmanya Medical Research Centre, Chinchwad. The clinical trial was registered with the Clinical Trial Registry-India (CTRI) under the registration number CTRI/2023/02/049625.

Effectiveness comparison between nutritional formula and placebo capsules included efficacy evaluations at baseline, day 30, day 60, and day 90, assessing clinical progress, vitals, and other factors. Concomitant conditions and medications were recorded at screening and baseline. Efficacy assessments at screening, day 30, day 60, and day 90 included WOMAC A, B, and C subscale scores, OA-related symptoms, gastrointestinal symptoms, and reliance on oral/topical analgesic anti-inflammatory medications as rescue treatment. Additionally, changes in Kellgren Lawrence radiological severity grading, knee range of motion, CRP and IL-6 levels, KOOS and FACIT-F scores, as well as hematological and biochemical markers, were evaluated at screening and day 90. Safety and tolerability of the investigational treatment were monitored from randomization to day 90, assessing adverse events (AEs), serious adverse events (SAEs), and laboratory values.

Inclusion Criteria

Adults (both sexes, ages 18 to 60 inclusive) with BMI >30 kg/m2 were included in the study. A clinically confirmed diagnosis of knee osteoarthritis according to the criteria of the American College of Rheumatology (ACR) Knee discomfort accompanied by at least three out of six of the following symptoms crepitus, bony tenderness, bony enlargement, age >50 years, morning stiffness <30 minutes, and absence of palpable warmth are indicative of clinical OA of the knee were included. The subject reported a WOMAC-A pain score between 5 and 15 (both inclusive) at screening will be included.

Exclusion Criteria

Subjects with conditions including rheumatoid arthritis, systemic lupus erythematosus, psoriatic arthritis, pseudo-gout, and pain due to malignant diseases were not included. Those with indications for surgery for OA knee or a history of arthroscopy in the past year were excluded. Subjects who had used herbal medications or systemic steroids to treat OA within the past four weeks of screening were excluded. Additionally, individuals using vitamin D3 injections, GS, CS, diacerein, or alendronate within the previous three months, as well as those who had received injections of hyaluronic acid or intra-articular steroids within the last nine months, were excluded. Subjects with a history of osteoporotic or osteoarthritic fractures within the past 6 months were excluded. Pregnant or lactating women were also excluded. Subjects with uncontrolled diabetes mellitus, uncontrolled hypertension, cardiovascular disease, thyroid, hepatic dysfunction, renal dysfunction were excluded. Subjects with peripheral neuropathy or neurological disorders were excluded. Those with known alcohol abuse, medication, or drug dependence were also excluded.

Investigational Product Composition

Composition along with the content details is expressed in Table 1.

Table 1: Ingredients of nutritional formula capsules

Sr. No.	Name of the Ingredient	Amount per capsules
Natural Extracts		
1.	Collagen Peptides (*Marine Source*)	150 mg
2.	Glucosamine Sulphate	500 mg
3.	Chondroitin Sulphate	100 mg
4.	Rose Hips Extract	40 mg
5.	Curcumin (*Curcuma Longa*)	50 mg
6.	*Boswellia Serrata Extract*	50 mg

7.	Omega-3-Fatty Acids (From natural source providing Alpha-Linolenic Acid)	150 mg
Vitamins		
8.	Vitamin D-3	400 IU
9.	Vitamin E Acetate	10 mg
10.	Vitamin C	30 mg
11.	Folic Acid	200 mcg
12.	Vitamin B12	1 mcg
Minerals		
13.	Zinc	5 mg
14.	Copper	500 mcg
15.	Manganese	2.5 mg
16.	Selenium	40 mcg

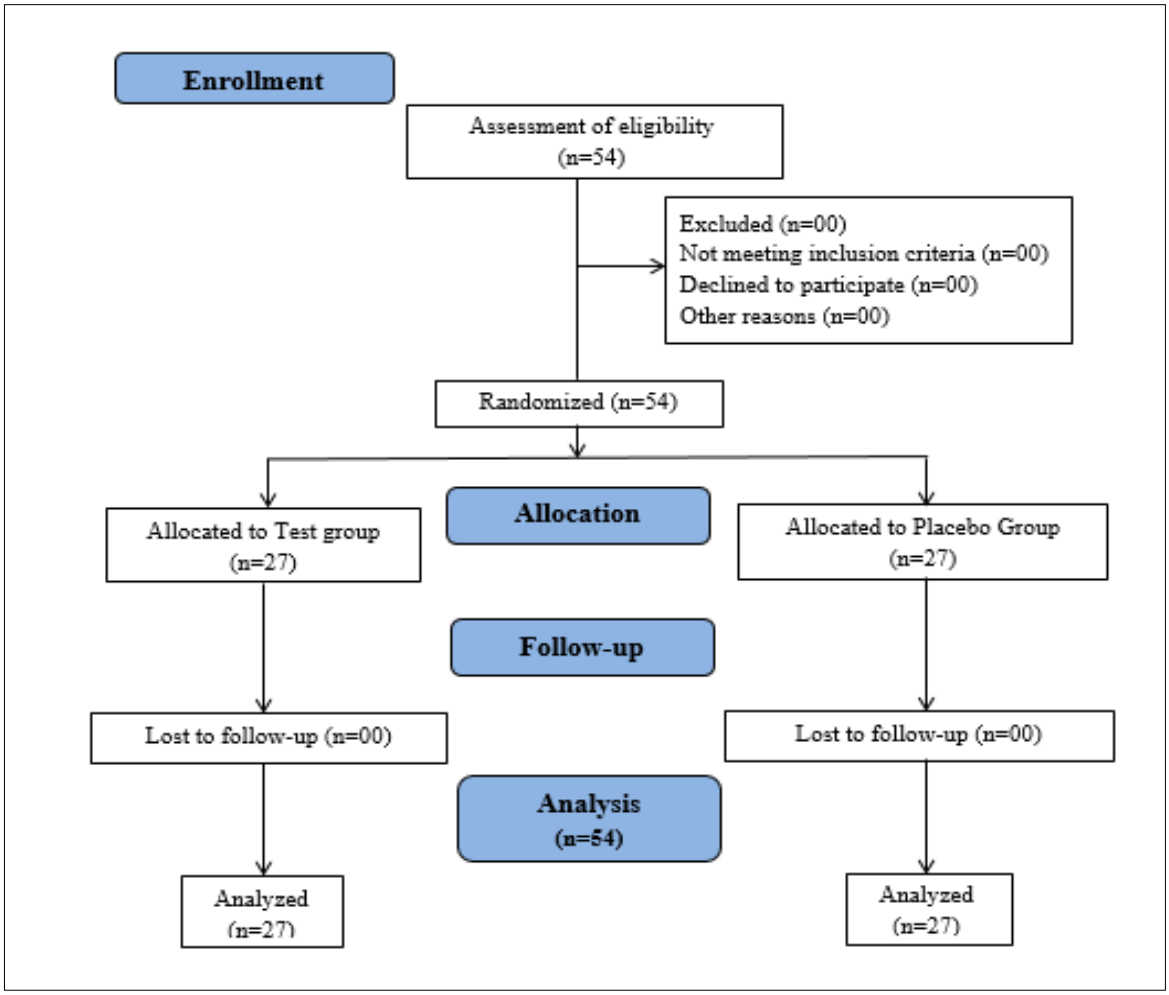

Figure 1: CONSORT diagram for the study

Statistical analysis

Statistical analysis has been done by using SPSS version 10.0. The primary and secondary endpoints were analyzed using a dependent and independent student's t-test, Wilcoxon sign rank test, and Mann-Whitney U test. The p-values ≤0.05 were considered statistically significant.

Results

Assessment of Demographic and lifestyle habits

The study population consisted of 54 subjects, with no statistically significant differences in gender distribution or age between the test and placebo groups. For males, the mean age in the test group was 35.61 ± 12.61 years, while in the placebo group, it was 36.21 ± 6.77 years. Similarly, in females, the mean age in the test group was 43.89 ± 13.36 years, and in the placebo group, it was 42.77 ± 7.88 years.

Assessment of anthropometric parameters

Anthropometric measurements for two groups the test group and the placebo group. Based on the provided data and the statistical analysis suggested that there was no significant change in the weight, height, and BMI of the study subject among both groups.

Assessment of WOMAC score

The WOMAC questionnaire comprises of pain, stiffness, and physical function and assesses on a scale from 0 to 4, with higher scores indicating greater difficulty. Reductions in total scores reflect improvement.

The test groups showed gradual yet significant reductions in all domains, while the placebo group did not. Significant differences between the groups were observed from day 30 onwards, indicating greater improvement in the test group. Pain scores decreased by 29.72%, 53.51%, and 66.87% on Days 30, 60, and 90, respectively, in the test group. Stiffness scores also decreased by 32.27%, 55.15%,

and 65.22% on Days 30, 60, and 90, respectively, in the test group. Physical function scores improved by 24.99%, 48.20%, and 67.19% on Days 30, 60, and 90, respectively, in the test group. These findings collectively indicate a significant enhancement in overall health and well-being over the study period (as shown in Table 2 and Figure 2).

Table 2: Assessment of changes in WOMAC score

VISIT	TEST	PLACEBO	P Value
Pain			
Screening	9.96 ± 2.93	9.74 ± 2.28	0.757
Day 30	7.00 ± 2.50	9.22 ± 1.69	<0.001
Day 60	4.63 ± 2.22	9.70 ± 1.88	<0.001
Day 90	3.30 ± 1.44	9.26 ± 1.65	<0.001
P value	<0.001	0.33229	
Stiffness			
Screening	4.37 ± 2.22	4.59 ± 1.67	0.680
Day 30	2.96 ± 1.79	4.33 ± 1.24	<0.001
Day 60	1.96 ± 1.51	4.52 ± 1.37	<0.001
Day 90	1.52 ± 1.09	4.48 ± 1.37	<0.001
P value	<0.001	0.52294	
Physical function			
Screening	30.81 ± 9.72	36.19 ± 7.13	0.024
Day 30	23.11 ± 11.19	33.70 ± 4.45	<0.001
Day 60	15.96 ± 10.30	35.67 ± 5.43	<0.001
Day 90	10.11 ± 7.77	34.70 ± 4.57	<0.001
P value	<0.001	0.29498	

All the data was analysed by Independent Student's T Test for between groups and Dependent Student's T Test for within groups. Significant at p-value <0.05.

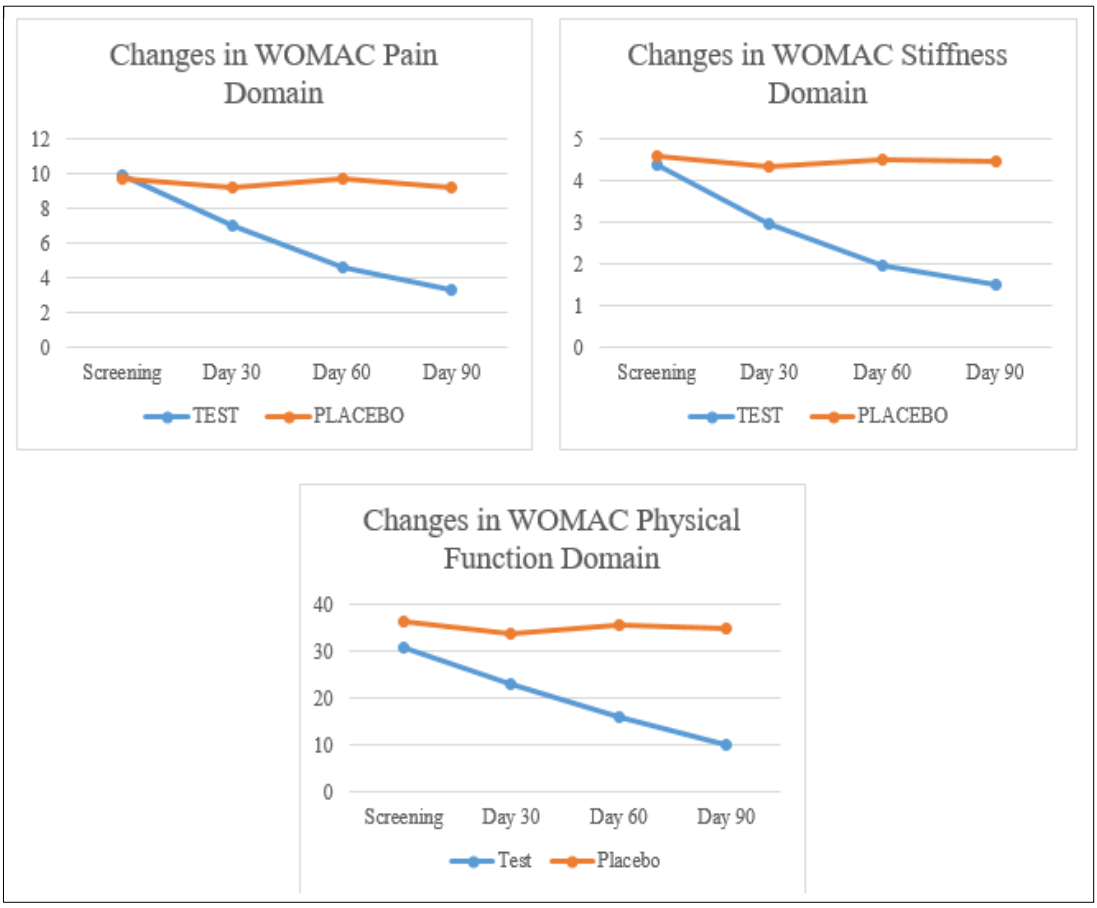

Figure 2: Changes in WOMAC score for pain, stiffness, and physical function domain

Assessment of range of motion (ROM)

The range of motion of the most affected knee joints was measured by a goniometer. Increased ROM angle indicates improved knee flexion.

At day 90, a significant increase in the mean flexion angle was observed in both test (8.85%) and the placebo group (0.65%). However, when compared there was more improvement observed in the test group and the difference was significant between the groups. These findings suggest that the test product has a significant positive impact on knee flexion, potentially indicating its efficacy in improving joint mobility consistently with WOMAC stiffness score over 90 days (as shown in Table 3).

Table 3: Assessment of changes in range of motion

VISIT	TEST	PLACEBO	
Most affected knee			**P value**
SCREENING	120.89 ± 3.68	120.52 ± 2.42	0.664
DAY 90	131.59 ± 2.53	121.30 ± 3.11	<0.001
P Value	<0.001	0.004	

All the data was analysed by Independent Student's T Test for between groups and Dependent Student's T Test for within groups. Significant at p-value <0.05.

Assessment of quality of life by using KOOS questionnaires

The Knee Injury and Osteoarthritis Outcome Score (KOOS) is self-administered and assesses five outcomes: pain, symptoms, activities of daily living, sport and recreation function, and knee-related quality of life. The KOOS meets the basic criteria of outcome measures and can be used to evaluate the course of knee pain and treatment outcomes.

The findings from the evaluation of the quality of life, which had a question (Q4) of "In general, how much difficulty do you have in the knee", this question reveal that the test group had a noteworthy 64% reduction in the participants as compared with placebo who had only 4.34% reduction. The results are significant and are vital for assessing the product's effectiveness in improving the quality of life for the subjects being investigated as shown in Table 4.

Table 4: Assessment of changes in quality of life by using KOOS score (Q4)

KOOS Score (Q4)			
	TEST	**PLACEBO**	**P Value**
SCREENING	46.30 ± 16.56	42.59 ± 13.54	0.4965
DAY 90	16.67 ± 15.50	40.74 ± 12.30	<0.001
P Value	<0.001	0.610	

For the KOOS Questionnaire, all the data was analysed by the Wilcoxon Test for within groups and the Mann Whitney U Test for between groups. Significant at p-value <0.05.

Assessment of changes in quality of life by using FACIT- Fatigue severity score

The FACIT-Fatigue scale is a 13-item patient-reported measure of fatigue, with each item scored on a response scale ranging from 0 to 4. The resulting score ranges from 0 to 52, where a score above 30 indicates severe fatigue and lower scores indicate less fatigue and better quality of life.

On day 90, the test group exhibited a notable 32.84% reduction in fatigue compared to a 0.45% reduction in the placebo group. These significant results are crucial for assessing the product's effectiveness in enhancing the quality of life for the subjects, as depicted in Table 5.

Table 5: Assessment of changes in quality of life by using FACIT- Fatigue severity score

FACIT FATIGUE SCORE			
	TEST	**PLACEBO**	**P Value**
Screening	33.37 ± 2.48	33.59 ± 2.44	0.68916
Day 90	22.41 ± 2.24	33.48 ± 2.01	<0.001
P Value	<0.001	0.952	

For the FACIT Fatigue Scale., all the data was analysed by the Wilcoxon Test for within groups and Mann Whitney U Test for between groups. Significant at p-value <0.05.

Assessment of gastrointestinal complaints:

Gastrointestinal symptoms, including heartburn, gastric discomfort, and epigastric pain, were assessed using a 4-point ordinal scale.

A significant increase in the number of subjects experiencing a reduction in the severity of these symptoms was observed in the test group compared to the placebo group. This difference became apparent from Day 30 and continued to improve thereafter. Thus, the test treatment has a substantial effect on alleviating gastrointestinal symptoms which can be attributed to decreased consumption of analgesic agents as pain and related symptoms were managed without analgesics.

Assessment of symptom grading

At screening, both the placebo and test groups were presented with homogeneous symptoms, showing no significant difference in joint swelling, tenderness, and warmth.

The number of subjects in the test group with no joint swelling increased from screening to Day 60. When compared between the groups, the test group showed a trend of a gradual decrease in swelling in the subjects compared to the placebo group and the difference was significant starting from day 30 which persisted till day 90.

Similarly, regarding tenderness, the test group exhibited a decrease in subjects with high tenderness by Day 90, with significant improvements observed from Day 30 onwards compared to the placebo group.

In terms of warmth, the test group showed a decrease in subjects with moderate, very, and slight warmth on Day 60 and Day 90, while no significant improvement was observed in the placebo group. Comparing the groups, the test group displayed a significant difference from Day 30 onwards, with fewer subjects experiencing higher warmth compared to the placebo group.

Assessment of changes in inflammatory markers, hematological and biochemical investigations

In this study, inflammatory markers including CRP, IL6, and ESR were evaluated. CRP and IL6 levels decreased significantly in both the test and placebo groups, with a more pronounced decrease in the test group.

However, ESR levels were significantly different between the groups at screening. After 90 days of treatment, ESR levels

decreased in the test group and increased in the placebo group, with a significant difference between the two groups. This suggests the potential of the test product in reducing inflammation (Table 6).

The safety of the product was also assessed using liver function, kidney function, and CBC in both groups. No clinically or statistically significant changes were observed in any parameters after 90 days of treatment except for a statistically significant alteration in serum creatinine levels, which did not have clinical significance (within the normal range).

Table 6: Assessment of changes in Inflammatory markers

VISITS	SCREENING		P Value	DAY 90		P Value
Inflammatory markers	**Test**	**Placebo**		**Test**	**Placebo**	
CRP	6.88 ± 4.82	7.40 ± 5.83	0.720	4.61 ± 3.35	7.97 ± 4.45	<0.001
IL6	18.12 ± 18.63	13.51 ± 21.46	0.051	13.27 ± 14.86	14.27 ± 19.24	<0.001
ESR	14.85 ± 6.61	18.43 ± 9.53	0.009	9.48 ± 5.45	20.74 ± 6.52	<0.001

All the data was analysed by Independent Student's T Test except for the Screening Visit, IL6, and ESR, which was analysed by the Mann Whitney U Test, For Day 90 Visit ESR was analysed by the Mann Whitney U Test. Significant at p-value <0.05.

Assessment of Kellgren Lawrence radiological severity of grade

Kellgren Lawrence's radiological severity grade employed was as follows: Grade 0 (none); Grade 1 (doubtful); Grade 2 (minimal); Grade 3 (moderate); Grade 4 (severe).

In the evaluation of 5 subjects from both the test and placebo group, all subjects were initially classified as Grade 1 (doubtful joint space narrowing and possible osteophytic lipping) at screening. This classification remained unchanged after 90 days of treatment in both groups.

Assessment of analgesics as a rescue medication

The knee joint pain that occurred during the study period was managed by advising subjects to use rescue analgesics which were Diclofenac, Aceclofenac + paracetamol, Aceclofenac, and Celecoxib as per the discretion of the investigator.

Results showed that subjects in the test group did not require any rescue medication, indicating the potential efficacy of the test product in alleviating symptoms of knee osteoarthritis. In contrast, eight subjects in the placebo group (approximately 30% of the total population) required rescue medications at Days 30, 60, and 90.

Assessment of changes in vital signs

At Day 30, 60, and 90, the test and placebo groups exhibited no clinically significant changes in systolic and diastolic blood pressure, heart rate, respiratory rate, and temperature between groups.

Assessment of tolerability and compliance

All the subjects from both groups demonstrated excellent tolerability and 100% compliance during throughout study visits.

Assessment of adverse events

Adverse events reported by subjects on days 30, 60, and 90 of a study. Muscle cramps, headache, backache, cold, cold and cough, fever, and cough were the reported adverse effects in a total twelve number of subjects (8 from the test group and 4 from the control group). All observed adverse events were mild and resolved within 1-2 days without medication, not attributable to the investigational products.

Discussion

The randomized, double-blind, placebo-controlled study demonstrated the efficacy and safety of nutritional formula capsules in subjects with knee osteoarthritis. The test group exhibited gradual and statistically significant improvements in pain, stiffness, and physical function scores compared to the placebo group, as assessed by WOMAC. Knee joint flexibility, measured by ROM, significantly improved in the test group. Symptom grading scores for joint swelling, tenderness, and warmth showed a significant decrease in the test group from day 30 onward. Quality of life and fatigue levels also improved considerably in the test group relative to the placebo. Notably, no rescue medication was required in the test group, while eight placebo subjects needed it, highlighting the analgesic efficacy nutritional formula. Inflammatory markers were significantly reduced in the test group compared to placebo. Safety assessments, including LFT, RFT, CBC, and vital signs, remained within normal ranges throughout the study in both groups. All adverse events were mild, unrelated to the study products, and resolved without medication. Excellent tolerance and 100% treatment compliance were observed in both groups, further underscoring the safety profile of nutritional formula capsules.

Research examining the effectiveness of glucosamine has documented comparable enhancements to the present study in physical function, stiffness, and pain levels [21]. It has the potential to maintain and regrowth of joint cartilage and repair joint structures, thereby mitigating the symptoms associated with OA [22,23]. Glucosamine, which is commonly employed in the treatment of OA would have demonstrated efficacy similarly in the present study as well.

In a similar vein, nutritional formula capsules comprise essential components including collagen peptides are known for their role in promoting joint and connective tissue health. Collagen peptides help in reducing inflammation in the joints, leading to consistent reductions in inflammatory markers [12,13]. Glucosamine and chondroitin sulphate are common joint health supplements. Glucosamine Sulphate biosynthesizes cartilage-building proteoglycans and glycosaminoglycans. Chondroitin sulphate, an essential cartilage component, and extracellular matrix (ECM) component has many benefits. Glycosaminoglycan synthesis, hyaluronan production, PGE2 decrease, oxidative stress protection, and chondrocyte death suppression were among these benefits [14]. These joint-supporting chemicals may have contributed to the test group's persistent and considerable pain, stiffness, and physical function improvements.

Curcumin, present in nutritional formula capsules aligns with its role in decreasing inflammatory cytokines, inhibiting matrix metalloproteinase, and relieving pain, swelling, and soreness to increase joint mobility [16]. The gradual and statistically significant improvements in the test group can be linked to the properties of curcumin as well. The standardized Rose hips extract used in subjects with OA demonstrated inhibition of leukocyte functions that cause cell injury in osteoarthritis. It also acted as a natural source of vitamin C with antioxidant potential, which could have contributed to its positive effects in reducing OA symptoms [14,15].

Boswellia serrata extract efficiently reduces inflammation and cartilage breakdown by inhibiting pro-inflammatory enzymes [17,18]. The test group's improvement in symptoms related to

tenderness, warmth, and swelling aligns with the potential anti-inflammatory effects of Boswellia serrata extract. The ingestion of omega-3 PUFAs was linked to improvements in osteoarthritis and rheumatoid arthritis symptoms [19,20]. The inclusion of omega-3 fatty acids in nutritional formula capsules likely contributes to the observed reduction in inflammation and improved joint mobility.

The addition of various vitamins and minerals, including Vitamin D-3, Vitamin E Acetate, Vitamin C, Folic Acid, Vitamin B12, Zinc, Copper, Manganese, and Selenium, further enhances the comprehensive nature of nutritional formula capsules. The assessment of the quality of life using KOOS questionnaires and the FACIT-Fatigue scale reflects the holistic impact of these vitamins and minerals on the overall well-being of the study participants.

The meta-analysis revealed that glucosamine and chondroitin sulfate may delay the radiological progression of OA after daily administration for over 2 or 3 years [24]. While the present study did not reveal structural changes based on the Kellgren Lawrence radiological severity classification, it demonstrated alleviation of pain, improved knee joint function, and symptom relief, consistent with prior research [25,26].

Research has investigated that the radiographic severity of OA does not accurately reflect the severity of pain, loss of function, and reduced range of motion. Our research study also aligned with the findings that the range of motion improved in both knees, possibly due to the reduction of knee pain where no significant alterations in the radiographical findings were seen [27,28].

Leveraging the unique mechanisms of each ingredient, nutritional formula capsules demonstrate a capacity to proficiently suppress inflammatory pathways, thereby mitigating cartilage damage and the progression of osteoarthritis. The promotion of anabolic pathways and the synthesis of crucial cartilage components underscore the potential of nutritional formula capsules in preserving joint health and function. A 2016 multinational study called the MOVES trial found the combination of glucosamine and chondroitin as effective at relieving knee OA pain and swelling as celecoxib, without the side effects. This combination could be a good alternative for people who aren't good candidates for NSAIDs because they have cardiovascular or GI conditions.

The short-term goal of incorporating supplements like nutritional formulas in osteoarthritis treatment is to reduce pain, dependency on analgesics, stiffness and improve function. Enhanced mobility can further improve muscle strength, decrease joint pain and stiffness, and lower the chance of disability due to OA. On a long-term basis, the nutritional formula can protect chondrocytes, which helps maintain cartilage structure and further reduce the progression of OA by reducing degeneration at joints [29].

In summary, the study furnishes compelling evidence supporting the effectiveness and safety of nutritional formula capsules, presenting a promising approach for the management of knee osteoarthritis and the improvement of overall well-being in individuals affected by this condition.

Conclusion

This study provides compelling evidence supporting the efficacy and safety of nutritional formula as a therapeutic intervention for knee osteoarthritis. Our findings underscore the multifaceted benefits of nutritional formula, demonstrating its anti-arthritic properties through significant reductions in pain, analgesic reliance, stiffness, and improvement in joint function, flexibility, mobility, and weight-bearing capacity. Moreover, the nutritional formula exhibits anti-inflammatory effects, as evidenced by reductions in CRP, ESR, and IL6 levels, suggesting its potential to attenuate inflammation associated with osteoarthritis. Additionally, the nutritional formula shows promise in promoting joint cartilage regeneration, although further investigations are warranted to assess its chondrocyte protective effect. This study reaffirms the safety and efficacy of the nutritional formula, offering a promising therapy for the management of knee osteoarthritis.

List of abbreviations

CRP: C-reactive protein
ESR: Erythrocyte sedimentation rate
IL6: Interleukin 6
OA: Osteoarthritis
MOVES: Multicenter osteoarthritis intervention trial with SYSADOA
PUFA: Polyunsaturated fatty acids
LFT: Liver function test
RFT: Renal function test
CBC: Complete blood count

Conflicts of Interest

All authors declare that there is no conflict of interest regarding the publication of this paper.

Funding Statement

Investigational product (RE-CART®) and testing expenses borne in the trial were supported by Cachet Pharmaceuticals Pvt. Ltd, India.

Acknowledgment

The authors would like to acknowledge the research team and the back-office team involved in the research work. We would like to acknowledge the support of Mprex Healthcare Pvt. Ltd., Pune, as a clinical research organization for this trial.

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