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The Impact of a Plant-Based Diet on Inflammatory Symptoms In Rheumatoid Arthritis: A Review

Justyna Moszkowicz
Clinical Provincial Hospital No. 2 in Rzeszow,
Lwowska 60, 35-301 Rzeszów, Poland
https://orcid.org/0009-0009-2582-6187
justynamoszkowicz@gmail.com

Tomasz Ufniarski
University Clinical Centre in Gdańsk,
Dębinki 7. 80-952 Gdańsk, Poland
https://orcid.org/0009-0008-6555-3403
tomasz.eku@gmail.com

Aleksandra Piech
Clinical Provincial Hospital No. 2 in Rzeszow,
Lwowska 60, 35-301 Rzeszów, Poland
https://orcid.org/0009-0001-4485-2200
aleksandra.r.piech@gmail.com

Martyna Grodzińska
Lower Silesian Oncology, Pulmonology and Hematology Center,
pl. Ludwika Hirszfelda 12, 53-413 Wroclaw, Poland
https://orcid.org/0009-0004-1001-6484
martyna.grodzinska@gmail.com

Maria Kleczkowska
Saint Adalbert Hospital in Gdańsk,
al. Jana Pawła II 50, 80-462 Gdańsk
https://orcid.org/0009-0008-5927-4811
marykle99@gmail.com

Karol Poplicha
National Medical Institute of the Ministry of the Interior and Administration,
Wołoska 137, 02-507 Warsaw, Poland
https://orcid.org/0009-0005-3835-9777
karol41299@gmail.com

Piotr Sobkiewicz
Lower Silesian Oncology, Pulmonology and Hematology Center,
pl. Ludwika Hirszfelda 12, 53-413 Wroclaw, Poland
https://orcid.org/0009-0007-6610-440X
piotr1999.sob@gmail.com

Karolina Pasierb
The University Hospital in Krakow,
Jakubowskiego 2, 30-668 Kraków, Poland
https://orcid.org/0009-0006-5806-3508
k.pasierb36@gmail.com

Patrycja Kardasz
Saint Adalbert Hospital in Gdańsk,
al. Jana Pawła II 50, 80-462 Gdańsk, Poland
https://orcid.org/0009-0006-8137-9789
patrycja.kardasz.med@gmail.com

Bartłomiej Siuzdak
Clinical Provincial Hospital No. 2 in Rzeszow,
Lwowska 60, 35-301 Rzeszów, Poland
https://orcid.org/0009-0003-8691-6617
bartlomiej.siuzdak@interia.pl

Marta Jutrzenka
Praga Hospital, Transfiguration of the Lord, Ltd.
al. Solidarności 67, 03-401 Warszawa
https://orcid.org/0000-0001-7266-1586
jutrzenkamarta@gmail.com

Corresponding author: Justyna Moszkowicz, justynamoszkowicz@gmail.com

Abstract:

Introduction: This review evaluates the impact of plant-based diets on the inflammatory symptoms in patients with rheumatoid arthritis (RA). RA is a chronic autoimmune inflammatory disease affecting approximately 1% of the global population and significantly impairing quality of life. Although pharmacological treatment with disease-modifying antirheumatic drugs (DMARDs) remains the cornerstone of therapy, but non-pharmacological interventions, including dietary changes, are also being recognised as important. Plant-based diets that are rich in fibre, antioxidants, and unsaturated fatty acids, have demonstrated anti-inflammatory properties that may modulate disease activity and improve clinical outcomes in RA patients. A systematic analysis of clinical trials and observational studies reveals that vegan, vegetarian, and plant-forward dietary patterns contribute to significant reductions in disease activity scores (DAS28), inflammatory markers such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), and subjective pain and physical function assessments with vegan, vegetarian, and plant-forward dietary patterns. Proposed mechanisms include decreased pro-inflammatory cytokines, improved gut microbiota diversity, weight reduction, and modulation of immune pathways such as autophagy. While the results are promising, further large-scale randomised controlled trials are necessary to clarify the optimal dietary approaches and their long-term benefits in RA management.

Objective: This review aims to assess the impact of plant-based diets on inflammatory symptoms in patients with rheumatoid arthritis (RA).

Materials and Methods: A review of the available literature from the PubMed, Scopus, and Web of Science databases published within the last 20 years.

Keywords: plant-based diet, rheumatoid arthritis, inflammation, rheumatic diseases, vegan diets, C-reactive protein (CRP).

1. Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory autoimmune disease that affecting approximately 1% of the global population [1,3]. RA significantly impacts patients' quality of life by limiting their ability to participate in daily activities and fulfil social roles. RA causes pain and negatively affects mental health and can ultimately lead to disability and premature death [2].

Women are affected three times more often than men. According to the 2019 Global Burden of Disease study, the global prevalence of RA was 0.22%, with rates of 0.31% and 0.13% in women and men, respectively [12]. RA most commonly affects the small joints of the hands symmetrically (e.g. the proximal interphalangeal, metacarpophalangeal, and metatarsophalangeal joints), the wrists and less frequently, larger joints such as the knees and shoulders (4). Additional symptoms may include low-grade fever, weight loss, muscle pain, fatigue, and skeletal changes. RA is a systemic disease that can lead to complications in the cardiovascular, respiratory, visual, and renal systems, as well as many other organs [1,2].

The aetiology of RA is not fully understood. It is assumed that genetic factors account for around 50% of the risk of developing the disease. The remaining risk is associated with environmental factors, some of which may be modifiable. These include smoking, infectious diseases, gut microbiota composition and diet. These factors play a role in the development and progression of RA [5,6,7].

The pharmacotherapy of for rheumatoid arthritis (RA) involves using disease-modifying antirheumatic drugs (DMARDs) and anti-inflammatory drugs, such as non-steroidal anti-inflammatory drugs (NSAIDs) and glucocorticosteroids (GCS). Non-

pharmacological treatments such as patient education, physical activity, physiotherapy, and a balanced diet are also important [13].

Adopting a plant-based diet adopted by patients with RA may play a significant role in the inflammatory processes associated with the pathophysiology of RA by reducing inflammation, altering gut microbiota composition, and supporting weight loss. When used alongside pharmacological treatment, which remains the primary therapy for RA, a plant-based diet can alleviate symptoms, increase the likelihood of achieving remission and reduce mortality risk, as well as lessen the side effects and costs associated with pharmacotherapy [3,4,8].

Numerous studies have demonstrated the connection between environmental factors and health improvement in RA patients. A diet based on animal products and excessive body weight can hinder the treatment of RA due to their pro-inflammatory effects. It has been observed that a plant-based diet, rich in fibre, has anti-inflammatory properties. It also helps maintain a healthy weight [1,9,10,11].

2. Plant-Based Diets: Definition and Nutritional Aspects

Nutritional therapy for rheumatoid arthritis (RA) involves adjusting the ratio of omega-6 to omega-3 fatty acids, as well as increasing antioxidant intake,in order to reduce inflammation. It also involves reducing arachidonic acid (AA), which is an omega-6 fatty acid. AA is involved in the metabolism of eicosanoids, which play a significant role in the development of inflammatory responses. Therefore, the fewer AA present in the cell membrane, the fewer eicosanoids are produced, resulting in a reduced inflammatory response (Figure 1) [14, 15]. Animal-based diets contain the highest amounts of AA, whereas vegetarian diets contain significantly less, and vegan diets virtually none at all. For this reason, a plant-based diet may have a beneficial effect on inflammatory processes [16, 17].

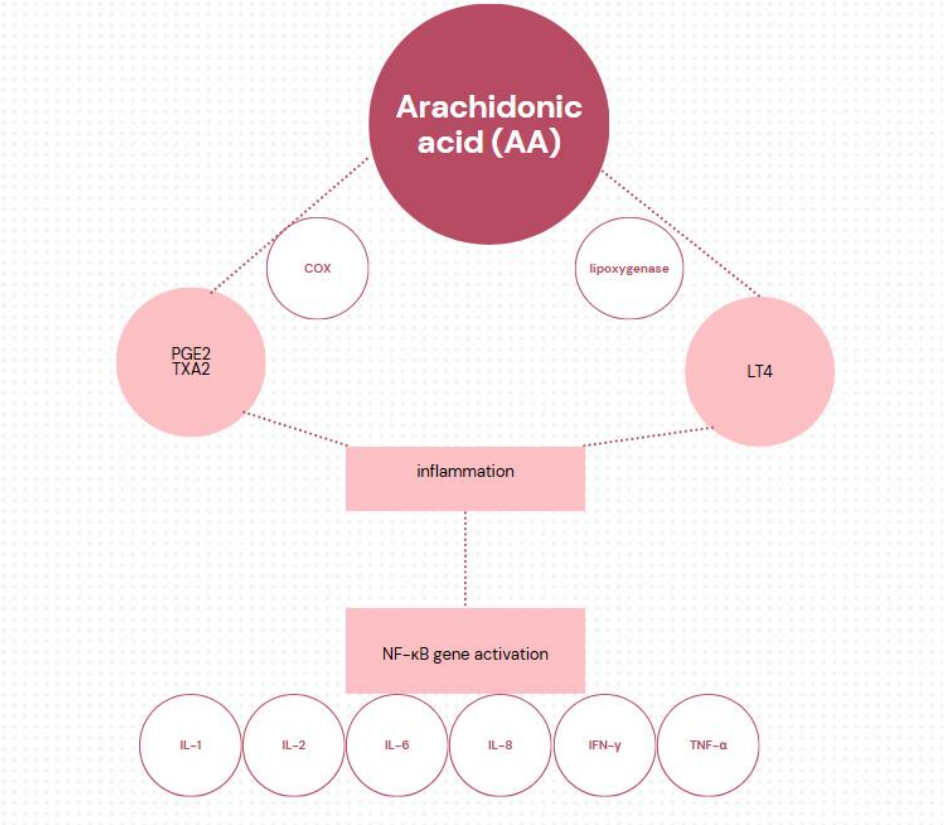

Figure 1. Diagram illustrates the underlying mechanism of inflammation development. Arachidonic acid (AA)- omega-6, COX- cyclooxygenase, PGE2- prostaglandyn E2, TXA2- thromboxane A2, LT4- leukotrienes. [14,15]

2.1.Types of plant-based diet

We distinguish between a vegan diet, which excludes all aproducts derived from animals, including meat, dairy products, eggs and honey. This diet is based exclusively on plant-based foods. In contrast, a vegetarian diet, on the other hand, excludes meat and fish but may include dairy products and eggs. There are various subtypes, such as the lacto-vegetarian, ovo-vegetarian, and lacto-ovo-vegetarian diets. Recently, the flexitarian diet has also become popular. This is primarily plant-based but allows for the occasional consumption of small amounts of meat, fish, or poultry. This is a more flexible approach is easier for many people to adopt (Table 1) [9, 18].

Diet Type	Animal Product Inclusion	Description	Common Nutritional Considerations
Vegan	None	Excludes all animal products	Risk of B12 deficiency; requires supplementation
Vegetarian	Includes dairy and eggs	Excludes meat and fish	Generally adequate protein, monitor iron intake
Flexitarian	Occasional meat, fish, poultry	Primarily plant-based with flexible animal inclusion	Easier adherence, balanced nutrient intake

Table 1. A comparison of plant-based diets [9,18].

2.2.Nutrient essentials and their anti-inflammatory properties

Plant-based diets are rich in nutrients with anti-inflammatory properties. They contain antioxidants, dietary fibre and unsaturated fatty acids. Plant-based foods are particularly high in antioxidants, including vitamins C and E, carotenoids, and polyphenols. These compounds neutralise free radicals, thereby reducing oxidative stress and inflammation. The high fibre content improves gut health by supporting beneficial microbiota and the production of short-chain fatty acids (SCFAs), which have anti-inflammatory properties. Nuts, seeds, and certain plant oils provide omega-3 and omega-6 fatty acids in favourable ratios, which can modulate inflammatory pathways. Unlike saturated fats of animal origin, unsaturated fats support cardiovascular and immune system health [1, 9, 18, 19].

2.3.Nutrient deficiencies in plant-based diets

The most common argument among opponents of such diets is that they do not provide all the essential nutrients. While plant-based diets have numerous health benefits, there is a risk of deficiencies in certain nutrients. One of the most critical of these is vitamin B12, which is only occurs naturally in animal-derived products. A deficiency in this vitamin can lead to megaloblastic anaemia and neurological disorders. Therefore, vitamin B12 supplementation is

essential for vegans. Plant-based non-haem iron has lower bioavailability. To improve iron absorption, it is recommended that you consume vitamin C-rich foods alongside meals containing iron. Calcium and vitamin D are essential for bone health. These can be found in fortified plant-based beverages and dark leafy green vegetables. Sun exposure for about 30 minutes daily, along with vitamin D3 supplementation, is key to maintaining adequate vitamin D levels. A varied plant-based diet provides sufficient protein. Combining legumes, grains, nuts, and seeds ensures the intake of all essential amino acids [1, 2, 9, 18, 19].

2.4.The Role of Gut Microbiota Composition in Health and Disease

Plant-based diets have a positive influence on the composition of gut microbiota, increasing the diversity and abundance of beneficial bacteria such as Bifidobacterium and Lactobacillus. These microorganisms ferment dietary fibre to produce short-chain fatty acids (SCFAs), including butyrate, acetate, and propionate. These SCFAs help to regulate the immune response and reduce inflammation in the body. Dysbiosis, or an imbalance in the gut microbiota, is associated with increased inflammation and can exacerbate autoimmune diseases, including rheumatic diseases. Therefore, modulating the microbiome through diet is a promising approach to treating inflammatory conditions [20].

3. Impact of Plant-Based Diets on Inflammatory Markers in Rheumatic Diseases

3.1.Review of clinical and observational studies

A growing body of evidence from clinical and observational studies suggests that plant-based diets, such as vegan, vegetarian and low-fat diets can alleviate symptoms and reduce inflammatory markers in patients with rheumatoid arthritis (RA).

A notable example is the randomised trial 'Plants for Joints', in which a 16-week lifestyle programme incorporating a whole-food plant-based diet, physical activity and stress reduction resulted in significantly lower DAS28 scores and CRP levels than were observed in the control group [21]. Importantly, improvements in DAS28 scores were still evident after two

years, with 44% of participants having reduced or discontinued their use of disease-modifying antirheumatic drugs (DMARDs) [23].

Previous studies, such as those by Kjeldsen-Kragh et al., have demonstrated that a fast of 7–10 days, followed by a vegan, plant-based diet for several months leads to significant reductions in DAS28, ESR, CRP, and the number of tender and swollen joints. This approach has also been shown to improve mobility and handgrip strength [24].

A more recent German randomised controlled trial (NutriFast; seven days of fasting followed by 11 weeks of time-restricted plant-based eating) found that participants experienced a rapid decrease in DAS28 (approximately –0.97 to –1.14 after 12 weeks), improved functionality (HAQ-DI) and favourable outcomes in terms of body weight and cardiovascular risk factors [25].

A systematic review of seven randomised controlled trials RCTs found that anti-inflammatory diets, such as vegetarian, vegan, and Mediterranean diets, significantly reduced pain on the VAS scale by an average of 9.22 mm (95% CI: –14.15 to –4.29), and lowered CRP and ESRlevels. However, the authors noted a low level of evidence and a risk of bias [14].

Finally, observational reviews and meta-analyses suggest that vegan and vegetarian diets are associated with lower CRP concentrations and improved gut microbiota profiles, which may indirectly contribute to remission [26].

3.2.Analysis of DAS28, CRP, ESR, VAS and Other Indicators

DAS28

Following plant-based dietary interventions, the reduction in DAS28 scores decreased by between approximately 0.9-1.0, which exceeds the threshold for clinical significance (~ 0.6–1.2). In the Plants for Joints study, improvements in DAS28 were sustained over a two-year period [23].

CRP and ESR

All of the aforementioned studies mentioned reported a significant decrease in CRP levels— from ~13 mg/L to ~5 mg/L after 12 months on a vegan diet in the study by Elkan et al. study. In the two-year follow-up, CRP remained consistently below baseline levels, while ESR remained relatively stable [24].

VAS and HAQ/HAQ-DI

Subjective pain perception, measured on the VAS scale, decreased by an average of 9–15 mm in RCTs and meta-analyses. In the NutriFast study, the HAQ-DI score improved significantly after just seven days (Δ –0.29, p=0.001) [25, 26].

Number of tender and swollen joints

Studies by Kjeldsen-Kragh and Elkan demonstrated reductions in both tender and swollen joint counts, alongside a 50% decrease in morning stiffness [24].

3.3.Plant-Based Diet, Functionality, and Quality of Life

In addition to improving clinical parameters, plant-based diets were found to have a positive impact on daily functioning (HAQ, HAQ-DI), mobility, and overall well-being. The Plants for Joints study demonstrated sustained improvements in general health status (the general quality of life component of DAS28) for at least two years [23]. Similarly, the NutriFast RCT and earlier studies demonstrated rapid improvements in work ability and reductions in fatigue.

3.4.Potential biological mechanisms

1. Reduction of pro-inflammatory Mediators: Plant-based diets are are high in fibre, antioxidants, and omega-3 polyunsaturated fatty acids, while being low in saturated fats. Together, these factors limit the production of pro-inflammatory cytokines, such as TNF-α, IL-1β and IL-6 and eicosanoids.
2. Alteration of Gut Microbiota: Dietary fibre acts as a prebiotic for beneficial bacteria, thereby increasing microbial diversity and reducing inflammation along the gut-joint axis.
3. Reduction of adiposity-related inflammation: Weight loss decreases in adipokines (e.g., TNF-α, IL-6), thereby helping to reduce inflammation in joint tissues.

4. Autophagy and modulation of the mTOR pathway: Therapeutic fasting followed by a plant-based diet may activate autophagy and inhibit the mTOR pathway, thereby promoting immune regulation and reducing inflammation [23,24,25,26].

Mechanism	**Description**
Reduction of pro-inflammatory cytokines	Decrease in IL-6, TNF-α, IL-1β, NF-κB
Alteration of gut microbiota	Increased microbial diversity, SCFA production, and gut barrier integrity
Decrease in adipokines	Weight loss → lower TNF-α and IL-6 levels
Autophagy / mTOR pathway modulation	Activation of autophagy, inhibition of mTOR, suppression of NLRP3 inflammasome

Table 2. Summary of Potential Biological Mechanisms Reducing Inflammation [23,24,25,26].

3.5.Summary

A plant-based diet appears to be a promising strategy for supporting the treatment of rheumatic diseases, particularly rheumatoid arthritis (RA). Data from randomised controlled trials (RCTs) and observational studies indicate significant reductions in DAS28 scores (by ~0.9–1.2), CRP, ESR, VAS scores. There are also improvements in health-related quality of life and physical function (HAQ), as well as a reduction in the use of disease-modifying antirheumatic drugs (DMARDs). These improvements are thought to be due to cytokine modulation, improvement of the gut microbiota, weight reduction, and activation of autophagy processes. However, despite these promising results, limitations remain. These include the heterogeneity of interventions (vegan vs. vegetarian vs. fasting), small sample sizes, and risk of bias. This highlights the need for further well-designed RCTs with larger sample sizes, as well as analysis of individual dietary patterns.

Marker/ Indicator	Description	Impact of Plant-Based Diet	Clinical Significance
DAS- 28	Composite score assessing tender and swollen joint counts in RA	Reduction by 0.8–1.5 points	Clinically meaningful improvement in disease activity
CRP	Acute-phase reactant indicating systemic inflammation	Decrease by 25–40%	Correlates with improvement in inflammatory symptoms
ESR	Marker of systemic inflammation, measures red blood cell sedimentation	Similar reduction as CRP	Objective indicator of inflammation
VAS	Measures pain intensity on a 0–100 mm scale	Reduction by 20–30 mm	Significant improvement in patient comfort
HAQ	Assesses physical function and daily activity capabilities	Improvement in physical function	Better independence and quality of life
SF-36	Measures physical and psychological quality of life	Improvement in physical and mental health scores	Enhanced overall well-being and mental health

Table 3. Summary (CRP- C-reactive protein, ESR- Erythrocyte Sedimentation Rate, VAS- Visual Analog Scale, HAQ- Health Assessment Questionnaire, SF-36- Short Form-36 Quality of Life) [1].

4. Discussion

The accumulated data clearly indicate that a plant-based diet can significantly support the treatment of rheumatoid arthritis (RA). It has been shown to have beneficial effects on inflammatory parameters (CRP, ESR), clinical outcomes (DAS28, number of tender and swollen joints) and patients' subjective experiences (VAS, HAQ). This issupported by randomised clinical trials and observational studies, including long-term projects such as Plants for Joints (Table 3).

The beneficial effects of a plant-based diet rely on multiple synergistic mechanisms, including the modulation of the gut microbiota, through the supply of anti-inflammatory components (fibre, antioxidants, omega-3 fatty acids) and impact on weight reduction, which decreases the burden on the immune and musculoskeletal systems. Reducing pro-inflammatory cytokines (e.g., TNF-α, IL-6) and improving intestinal barrier function also support symptom remission.

Although the results presented are promising, they should be interpreted with caution. Firstly, some analyses are limited by small sample sizes, a lack of randomisation or blinding, and heterogeneous approaches to dietary interventions (e.g., vegan, vegetarian or flexitarian diets). Additionally, the effect of the diet may be difficult to distinguish from that of other lifestyle interventions such as physical activity, stress reduction, or intermittent fasting. Therefore, drawing definitive conclusions about the effectiveness of the diet alone require further well-designed studies that control for confounding variables.

In the context of clinical practice, it is worth noting that a plant-based diet is a relatively low-risk, non-pharmacological intervention offering additional benefits such as improved lipid profiles, blood sugar regulation, and the prevention of cardiovascular disease. For patients with rheumatoid arthritis (RA), it can significantly enhance quality of life and reduce treatment costs, both directly by decreasing the need for disease-modifying antirheumatic drugs (DMARDs) and by increasing productivity while reducing the burden on healthcare systems.

From a perspective of healthcare quality management perspective, dietary interventions for chronic diseases should be integrated into coordinated care models and patient education programmes. Developing nutritional standards specifically for rheumatology patients could improve treatment effectiveness and patient satisfaction. Future research should include cost-effectiveness analyses of plant-based diets compared to conventional pharmacological treatments.

Research should also investigate the long-term prognosis, including the risk of cardiovascular complications and depression associated with RA. An integrated approach to nutrition, involving personalised dietary recommendations and microbiome assessment, could represent a new direction in the treatment of inflammatory diseases.

5. Conclusions

This review confirms that plant-based diets can alleviate the symptoms of inflammation in patients with rheumatoid arthritis. Evidence from clinical and observational studies suggests that these diets reduce levels of inflammatory markers such as C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and DAS-28 scores. This leads to reduced pain,

improved joint function and an enhanced overall quality of life. The anti-inflammatory effects of such diets are largely attributed to their high fibre, antioxidant, and beneficial fatty acid content.

Incorporating plant-based nutrition as a holistic component of treatment represents is a promising non-pharmacological strategy that can complement standard therapeutic approaches. Such dietary interventions may also offer metabolic benefits, reduce the risk of cardiovascular events, and support gut microbiota health—factors that are crucial in the management of chronic rheumatic diseases.

In clinical practice, healthcare professionals should consider recommending plant-based diets alongside traditional treatments, tailoring their recommendations to ensure that each patient receives adequate amounts of all essential nutrients.

Disclosures

Author's contribution

Conceptualization: Justyna Moszkowicz, Aleksandra Piech
Methodology: Karolina Pasierb, Tomasz Ufniarski
Software: Martyna Grodzińska, Maria Kleczkowska
Check: Karol Poplicha, Piotr Sobkiewicz, Patrycja Kardasz
Formal analysis: Bartłomiej Siuzdak, Marta Jutrzenka, Aleksandra Piech
Writing -rough preparation: Justyna Moszkowicz, Pasierb, Tomasz Ufniarski, Martyna Grodzińska
Writing -review and editing: Maria Kleczkowska, Piotr Sobkiewicz, Patrycja Kardasz
Visualization: Bartłomiej Siuzdak, Marta Jutrzenka, Aleksandra Piech
Supervision: Justyna Moszkowicz, Karolina Pasierb, Tomasz Ufniarski

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