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Review Article

IMPACT OF COVID ON NUTRACEUTICAL MARKET: A REVIEW OF RECENT CHANGES AND FUTURE ASPECTS

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ABSTRACT

Last year, where the world was busy in battling with various economic, religious and geopolitical issues, a virus came throughout the world and spread rapidly among the people and affect all the people continuously. This virus made us realize what really matters. This disease named SARS-COv-2(COVID-19). The WHO has declared this disease a pandemic. There is no effective treatment or vaccine available at that time and this situation has led to a global health emergency. Then,compelling evidence suggests that certain nutraceuticals and plant based compounds may potentially be used in the treatment of COVID-19. People all over the globe to place emphasis on preventive healthcare and highlighted the use of nutraceuticals as a preventive cure. Clinical research on nutraceutical product is going on for integrating and assessing information. India will be a strong market to grow for nutraceutical products as the players in the industry will be a combination of large multi-nationals global for nutraceutical is growing day by day and is expected to reach USD 722.49 billion by 2027 from USD 382.51 billion in 2020, at a CAGR of 8.3% during the forecast period 2020-2027.In India, nutraceuticals are expected to have a worldwide market share of at least 3.5% by 2023. Therefore, the aims of the present review article are two different ways:- First to high lighten the nutraceuticals and the their role in the treatment of Covid-19. Secondly the Global Nutraceutical market growth analysis report and their future impact.

Key words: Nutraceuticals, Covid-19, Market growth report.

INTRODUCTION:

The term "NUTRACEUTICALS" was first framed in 1989 by Stephen De Folice, which is derived from "nutrition" and "pharmaceuticals". According to De Felice, A Nutraceuticals can be defined as a food that provides medical or health benefits. They are detoxifying our body, restoring our healthy digestion and dietary habits also. The term is applied to products that are isolated from herbal products, dietary supplements (nutrients), specific diets, and processed foods such as cereals, soups, and beverages that other

than nutrition are also used as medicine (WHO,2019; Savant et al., 2021).

A Nutraceuticals may be used to improve health, delay the aging process, prevent chronic diseases, increase life expectancy, or support the structure or function of the body. Some popular nutraceuticals include ginseng, Echinacea, green tea, glucosamine, omega-3, lutein, folic acid, and cod liver oil. Nowadays, nutraceuticals have received considerable interest due to potential nutritional, safety and therapeutic effects. It spans across Functional Foods, Functional Beverages and Dietary supplements. Some instances of Nutraceutical products are Probiotics, Fortified energy drinks, Vitamins and Minerals etc. The category is positioned in between Food & Beverages and Pharmaceuticals (Parisi et al., 2021; Fernandes, 2019).

Categories of Nutraceuticals:- Nutraceuticals are non-specific biological therapies used to promote wellness, prevent malignant processes and control symptoms. These can be grouped into the following three broad categories (Lordan et al., 2021):

1. Substances with established nutritional functions, such as vitamins, minerals, amino acids and fatty acids - Nutrients

2. Herbs or botanical products as concentrates and extracts - Herbals

3. Reagents derived from other sources (e.g. pyruvate, chondroitin sulphate, steroid hormone precursors) serving specific functions, such as sports nutrition, weight-loss supplements and meal replacements – Dietary supplements

Nutrients:- The most commonly known nutrients are anti-oxidant, water and fat-soluble vitamins. Many potential benefits have been attributed to anti-oxidant use in the form of dietary intake or supplementation. Anti-oxidants, in general, may be useful in the prevention of cancer and cerebrovascular disease. High dietary intake of vitamin E may prevent Parkinson's disease, the oxidized form of vitamin C, dehydroascorbic acid, readily crosses the blood brain barrier.That's why these are used in the treatment of Alzheimer's disease; combination of vitamin E, C and beta carotene has been useful in reducing low density lipoprotein oxidation and subsequent atherosclerosis (Gupta et al., 2010).

Herbals:-Herbals are as old as human civilization and they have provided a complete storehouse of remedies to cure acute and chronic diseases. The knowledge of herbals has accumulated over thousands of years so that today we possess many effective means of

ensuring health care. Herbal extracts, including b-sitosterols (found in Saw Palmetto berry), cernilton (pollen extract), and pygeum africum (African plum) have been clinically evaluated for use in the treatment of benign prostatic hyperplasia (Koe, 2020).

Dietary supplements: - Dietary supplements, also known as food supplements or nutritional supplements are preparation intended to provide nutrients, such as vitamins, minerals, fiber, fatty acids or amino acids that are missing or are not consumed in sufficient quantity in a person's diet. Dietary supplements have also been reported to manage a variety of diseases. Other common foods that may have potential therapeutic value include edible mushrooms. For example, several species of edible mushrooms in order of decreasing cultivated tonnage, Lentinus (shiitake), Pleurotus (oyster), Auricularia (mu-er), Flammulina (enokitake), have varying degrees of immunomodulatory, lipid lowering, antitumor and other therapeutic health effects without any significant toxicity. Zbar and NiteBite are two products in the form of bars that contain sucrose, protein and uncooked starch in order to provide continuous glucose release to diabetics during the night. Buckwheat proteins have unique amino acid composition with special biological activities of cholesterol-lowering effects, anti-hypertension effects and improving constipation and obesity by acting similar to dietary fiber and interrupting the in-vivo metabolism. Buckwheat flour can improve diabetes, obesity, hypertension, hypercholesterolemia and constipation (Rautiainen et al., 2017).

Overview on COVID

Coronavirus disease 2019 was first officially diagnosed in the city of Wuhan, China in January 2020.Very soon this disease became a global pandemic due to the suppression of information in the country of origin and inadequate testing for the Covid-19 virus. On 30 January 2020, the World Health Organization declared the COVID-19 pandemic a Public Health Emergency. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infects upper respiratory tract epithelial cells manifesting mild symptoms. Severe pneumonia can develop when the virus enters alveoli of the lungs and infects them, leading to the development of respiratory failure and acute respiratory distress syndrome (ARDS) (Baud et al., 2020). In severe cases of COVID-19, the virus can enter the bloodstream and infect endothelial and other target cells in the kidneys, esophagus, bladder, ileum, heart tissues, and central nervous

system. Currently vaccines are not available. Researches are ongoing period and those emergency situation, Nutraceuticals and other phyto-mineral supplements appear to be promising alternative solutions for the prevention and treatment of Covid-19. This is presenting an almost never-seen-before situation that will compel nutraceutical companies to evaluate their supply chains and adapt to new systems faster than ever before (Hardy,).

Role of Nutraceutical in the Treatment of COVID-19

Historically, many nutraceuticals have been attributed beneficial properties towards human health. However, the causal link between the intake of a certain substance, such as a vitamin, and the prevention of infectious events is not always demonstrated, so even today, the intake of nutraceuticals to prevent infections, especially respiratory infections. This concept becomes even more important in the context of the ongoing COVID-19 pandemic [Wolvers,].

1. Probiotics and Prebiotics:- Probiotics are living microorganisms that can have beneficial effects on the host if ingested in a certain quantity. Prebiotics are non-digestible micronutrients, often oligosaccharides, which selectively stimulate the growth and activity of one or a limited number of bacterial species of the intestinal bacterial flora, contributing to the reduction of intestinal pH, thus making the environment inhospitable for pathogenic bacteria. The known beneficial effects of probiotics schematically include the following: the biosynthesis of vitamin K; metabolic effects of fermentation of undigested dietary fibers; a positive influence on intestinal peristalsis; and modulation of the immune response. Probiotics seem to have a undefined role in modulating mucosal immunity. They can regulate the activity of many cells of the immune system, including both innate immunity (NK cells, macrophages, granulocytes, dendritic cells, and epithelial cells) and adaptive immunity and regarding COVID-19, experience with other viral strains, such as influenza, rhino virus, and respiratory syncytial virus, has led some to conclude that probiotic supplementation can be considered for the prevention of SARS-CoV-2 infection [Giannoni,].

2. Resveratrol:- Resveratrol is a polyphenolic compound present in various plant species, some of which are consumed by humans (mulberry, peanuts, and mainly red grapes/wine), where it performs antifungal functions. Many biological actions have been attributed to resveratrol, including antioxidant, anti-inflammatory, anti-platelet, cardio-

protective, anti-carcinogenic, and immune-modulatory activities, as well as induction of lymphocyte proliferation, activation of NK cytotoxicity, and mechanisms of apoptosis regulation. In vitro experiments on animal and human cells have shown that resveratrol has antiviral activity against numerous viruses (VZ, Herpes simplex, polyomavirus, influenza A, HIV). Finally, resveratrol intake might have a significant effect on susceptibility to or severity of SARS-CoV-2 infection (Jayawardena, 2020).

3. Hesperidin:- Hesperidin has been tested for several pharmacological activities, such as anti-atherogenic, antihyperlipidemic, antidiabetic, cardioprotective, antioxidant, and anti-inflammatory actions. Hesperidin enhanced cell-autonomous immunity, which is essential for cell defense mechanisms against influenza virus, selectively modulating the MAP kinase pathways. Moreover, hesperidin prevented the influenza A virus replication by inhibition of viralsialidase activity that is involved in the entry and release stages on virus infection. Several recent papers suggested that hesperidin presents a chemical-physical structure suitable for binding to critical proteins involved in the functioning of SARS-CoV-2.Results showed that, among a range of natural substances with potential antiviral effects. It showing that hesperidin has a stronger interaction with the SARS-CoV-2 protease than lopinavir, which is currently in clinical trials for COVID-19. The cytokine storm, a condition exhibited by patients with COVID-19, is an inflammatory response that evolves into an uncontrolled over-production of soluble markers of inflammation, such as Interferons, interleukins (IL-1, IL-6), and TNF (Baud, 2020).

4. Quercetin:- Few studies confirmed the quercetin potential as an antiviral agent, highlighting its effect on entry and consequent infection of different influenza viruses, including H1N1, H3N2, and A/WS/33. Virus entry is the initial step of the viral replication cycle; prevention of this crucial step leads to the suppression of viral infectivity. The antiviral effect of flavonoids on coronaviruses showed that quercetin reduced infectivity of human and bovine coronaviruses, OC43 and NCDCV. Although recent studies suggested the role of quercetin as a possible control the replication and the early phases of SARS-CoV-2 infection. Only a few clinical trials have been conducted to analyze the effect of quercetin on the prophylaxis and treatment of COVID-19 [Yang et al.,].

5. Lactoferrin:- Lactoferrin has antibacterial, antiviral, antioxidant, and immunomodulatory

functions. As for viral infections, lactoferrin appears to inhibit the attack of viruses on their receptors on human cells. The potential spectrum of activity of lactoferrin against SARS-CoV-2 comes from observations. It has been shown that lactoferrin has antiviral properties mainly through three mechanisms: direct binding to the virus; binding of lactoferrin with heparan sulfate proteoglycans (HSPGs), which are the adhesion molecules of many viruses on the surface of the host cell, thus acting with a competitive mechanism; and intracellular inhibition of viral replication. It is also able to enhance the antiviral action of T and NK 20 lymphocytes (Li et al., 2006).

6. Vitamin C:- Vitamin C belongs to water-soluble vitamins and is involved in many different biochemical mechanisms related to the cellular environment of most living organisms. AA represents one of the most known "scavenger molecules", showing an efficient antioxidant activity. Vitamin C is involved in the regulation of many biological pathways behaving as a multifunctional cofactor. The clinical and biological importance of vitamin C is against the viral infections, such as herpes virus (HSV), influenza type 1, HIV, and rhino virus, and inflammation. Different studies show that AA's antioxidant property is useful to reduce the oxidative damage in infected cells inducing inflammatory lung injury, often associated with mechanical ventilation. Vitamin C seems to be essential to enhance the immune system and also supports neutrophils to phagocyte and kill pathogens. The various roles of vitamin C and its involvement in COVID-19 clinical implications are shown by many clinical studies that confirm the efficiency of AA supplementation towards symptoms, duration of intensive care unit (ICU), and clinical resolution of the disease (Wahedi et al., 2020).

7. Vitamin D:- Vitamin D enhances the body's immune response. This vitamin exerts an anti-infective activity through its ability to favour the synthesis of some peptides with powerful antimicrobial activity (cathelicidin or LL37 protein). Vitamin D supplementation can help improve lung function in children with bronchiolitis and reduce the likelihood of developing respiratory infections. Daily administration of vitamin D to obese individuals, healthcare professionals, and smokers might improve resistance to COVID-19.Vitamin D can reduce the risk of viral infections and that vitamin D deficiency can contribute to acute respiratory distress syndrome. Therefore, Doctors recommend the use of vitamin D supplements and/or exposure to the summer sun to increase serum

concentrations to strengthen the immune system. Vitamin D supplementation is effective when used before the onset of the respiratory tract infection. Vitamin D administration significantly reduced the need for ICU treatment of patients requiring hospitalization due to proven COVID-19. An observational study, which presented a protocol for nutritional supplementation early on to patients hospitalized with COVID-19 (Kode et al., 2006).

8. Zinc:- Zinc is an essential mineral present in the body in quantities greater than that of any other trace element other than iron, it contributes to the stabilization of the cell membrane (cytoskeleton); and regulates apoptosis by lymphocytes in vitro and in vivo. The role of zinc in the integrity of the immune system is well known, and health interventions, such as zinc supplementation, have been hypothesized to prevent alteration of the immune system and improve resistance to infections. Zinc is considered useful for the respiratory mucosa as it seems to increase the beat frequency of cilia, resulting in an improvement in mucociliary clearance; moreover, this element contributes to inhibition of the replication of some viruses, such as influenza and rhinoviruses, and for this reason, it might also be effective in inhibiting the replication of SARS-CoV-2.Regarding the association with COVID-19, the role of zinc was analyzed for its synergistic action with chloroquine and hydroxychloroquine, drugs to which antiviral properties had been attributed (Garg et al., 2001).

9. Vitamin A:- Vitamin A1 or Retinol is a fat-soluble vitamin and an essential dietary factor. Vitamin A functions are mediated by all-trans-retinoic acid, which regulates the expression of several genes by binding specific nuclear transcription factors. In immunity, vitamin A supports the integrity of gastrointestinal epithelial tissue among children suffering from severe infections or who are undernourished. This vitamin is also important in the regulation of NK cells, macrophages, and neutrophils. Vitamin A plays a regulatory role in the early differentiation stage of NK cells, causing down regulation of IFN- and up regulation of IL-5. Furthermore, it regulates the differentiation of dendritic cell precursors and promotes the secretion of pro-inflammatory cytokines IL-12 and IL-23. Antibody production could be enhanced by the action of vitamin A on T-helper 2 cells development and antigen-presenting cells (APCs). Moreover, retinoids play a role in cell-mediated immunity, representing an important cofactor in T- cell activation and acting on the expression of

membrane receptors that mediate T-cell signaling (Parhiz et al., 2015).

10. Omega-3 (W-3) Fatty Acids:- W-3 fatty acids are a type of polyunsaturated fatty acids (PUFAs) characterized by the presence of a double bond at the W-3 carbon atom. These cannot be synthesized sufficiently by humans, so they must be obtained from the diet. W-3 fatty acids provide energy for the body operating several functions in the cardiovascular, pulmonary, immune, and endocrine systems. Indeed, both W-3 and W-6 metabolites play a role in immunity regulation. PUFA serve as a substrate for the enzymatic production of molecules involved in the resolution of inflammation. These molecules are different from the immunosuppressive agents because they further display antimicrobial action promoting host defense, these molecules are important in supporting immune cell function, neutralizing and eliminating pathogens with the resolution of inflammation. Moreover, SPMs has a strong anti-inflammatory action, reducing neutrophil activation and preventing tissue damage. They are also able to stimulate NK cells to trigger granulocytes apoptosis, accelerating the clearance of apoptotic polymorphonuclear leukocytes. Several studies have investigated the link betweenW-3 fatty acid supplementation and respiratory infections/illness and in particular the role in improving the ARDS (Saha et al., 2009).

11. Vitamin K:- Vitamin K belongs to the fat-soluble vitamin family and represents a fundamental nutrient involved in many biochemical and physiological processes. Besides coagulation, vitamin K is involved in the immune response associated with vascular damage: it enables the interaction between TAM receptors and their Gla-proteins ligands, PROS1 and growth-arrest-specific 6(GAS-6). Vitamin K2 is involved in the activation of matrix Gla-protein, which represents the main calcification inhibitors in soft tissues. This evidence suggests a correlation between vitamin K deficiency in COVID patients and worsens clinical course due to the enhanced fiber mineralization. Actually, it has been reported that vitamin K deficiency is strongly associated with admission to ICU (Wu et al., 2020).

NUTRACEUTICALS MARKET

Globally, Nutraceuticals market is expected to witness huge growth. At the turn of the millennium, between 1999 and 2002, the industry grew at a CAGR of 7%. Subsequently till 2010, it doubled to 14%. Currently every year $12-15 Billion is being added to the global revenue. The US and Japan have been pioneers

in embracing Nutraceuticals. Developing markets like India, Brazil and China are relatively smaller, yet have a huge growth opportunity. Indian market currently has a 2-3% share of the global market (Bellavite and Donzelli, 2020).

The Indian Nutraceuticals market is estimated at around $4 Billion in 2017 and is expected to grow at a significant 21% CAGR to $10 Billion in 2022. This will likely be fueled by a significant 25% per annum growth in Functional Beverages market accompanied by similar potential growth from the other segments. More than 60% of this market is accounted for by Dietary supplements. The global nutraceutical market in 2011 was estimated to be $149.5 billion, with US, Europe and Japan being the largest regional markets, accounting for nearly 93 percent of the global nutraceutical demand. The market is showing a continuous growth since 2006 with a compound annual growth rate (CAGR) of 18.90 % till 2010 and after that its growth is showing an upward movement with 26.95% when compared between 2009 and 2010.The Indian nutraceuticals market has grown from $ 1 billion in 2008 to $1,820 billion in 2013. The market is expected to cross $2 billion by 2014. According to a report by business research and consulting firm Frost & Sullivan, The Indian nutraceutical market, valued at $1480 million in 2011 and approx $1,700 million in 2012 and could grow to $2731 million in 2016 at a CAGR of 13.0 percent (Das et al., 2020).

Market Size:- Globally, Nutraceuticals market is going to experience huge growth in the next 10 years or so. However, emerging market consumers are becoming increasingly aware of the benefits of such products. Alongside, disposable income of general population is also increasing exponentially in many developing nations including India (Coppola and Mondola, 2020).

Figure 1: Indicate the growth of nutraceuticals market since 1999-2019 and so on.

Global Market Growth & General Demand Scenario:- As is evident, while in the initial years, between 1999 & 2002 industry grew at 7% per annum, the next few years up to 2010 saw double that growth at 14% per annum. Currently around $12-15 Billion is being added every year.70% of this population live in developed nations & balance 30% in developing nations. Nutraceutical demand will grow at a steady rate in developed nations and growth in next 5-10 years (Coperchini et al., 2020).

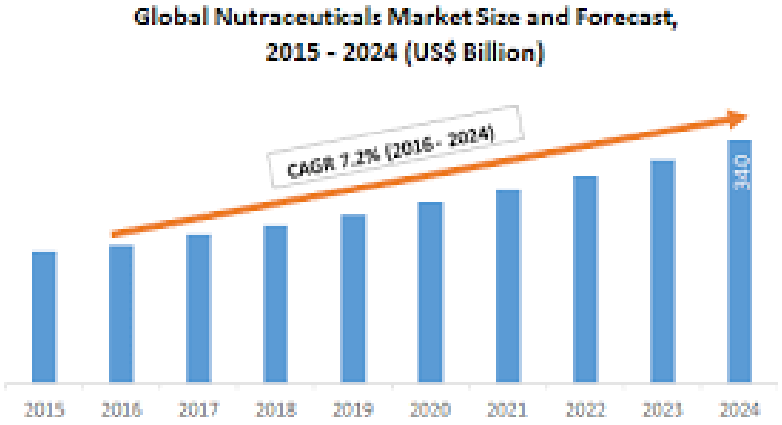

Figure 2: Global nutraceuticals market growth rate

US & Other Markets:- The US has been the largest Nutraceutical market so far and almost fully mature. Between 2010 & 2015 it grew from $ 50 Billion to $ 65 Billion, a compounded growth of 10% annually. The US market comprises of Functional Food & Beverages (65%) and Dietary Supplements (35%). The European market has grown from $ 35 Billion in 2010 to $ 40 Billion in 2016. It is expected to grow to $51 Billion by 2021. This indicates an annual growth of 5%. France, Germany & Switzerland are the biggest markets comprising almost 70% of the European market [Tejada et al., 2018].

INDIAN NUTRACEUTICAL MARKET

Indian Market Size & Growth:-The Nutraceuticals market is expected to grow from $4 Billion in 2015 to $10 Billion in 2022.This represents a huge growth of 21% annually.

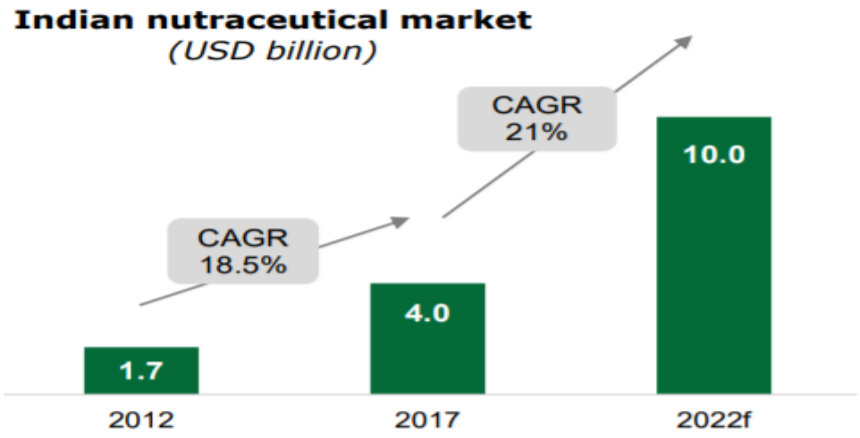

Figure 3: Represent a growth of Indian nutraceuticals market

Transformation in food habits, less physical work, more of desk jobs have made Indians more vulnerable to lifestyle ailments. The average urban & semi-urban Indian is becoming more conscious about health & fitness. This is providing a massive growth opportunity for Nutraceuticals in India (Stricker and and Fesler, 2020).

Drivers of Growth:- There are a host of factors which will drive growth of nutraceutical industry in India. Notable among them are:-

- Consumer awareness on health problems and their urge to take preventive steps
- Fitness intent – which is increasing at a fast pace
- Healthcare cost Indian Nutraceuticals Industry
- Low incidence of health insurance in India – large population still uncovered
- High incidence of diabetes, hypertension, Cardio-vascular ailments, Osteo-arthritis, Osteoporosis etc.

Expected effect of covid on nutraceutical market

- In India, this pandemic has pushed the people to polarize thoughts on the importance of preventive health and here is clear visibility on the impact created by pandemic on nutraceuticals industry in India (Haggag et al., 2020).
- In 2020, market size of the nutraceuticals industry was USD 382.51 billion. The worldwide market size of nutraceuticals is estimated to be USD 722.49 billion by 2027, which is growing at an annual compound growth rate of 8.3% by 2020-27.
- In 2020, U.S. had more than 27.1% of the worldwide market share and USD 63.3

billion market in nutraceuticals. Over the timeframe of 2020-25, it is expected to grow by 6.1% in nutraceuticals. With CAGR of 9.6% and an estimated US $ 77.2 billion in the market, China exhibits the potential to rise by the year 2027 (Sime et al., 2001).

- In India, nutraceuticals are expected to have a worldwide market share of at least 3.5% by 2023.The nutraceuticals industry in India accounts for 2% of the world economy at USD 388 trillion. Since, the pandemic encouraged people to eat more and more multi-vitamins to increase their immunity, there is a predicted increase by 20% in the dietary supplement industries. Use of Vitamin C, Vitamin D, E3 and probiotics have been tremendously increased since Covid-19 (Vitiello et al., 2020).
- In the coming 10 years, the nutraceuticals industry has potential to grow up to the size of $25-30 billion dollars. By 2030, the market will touch USD 10 trillion dollars, which is quadrupling growth of the Indian economy. The Indian market has been growing much faster for the last 3 years, driven by functional beverages and food categories (Li et al., 2016).

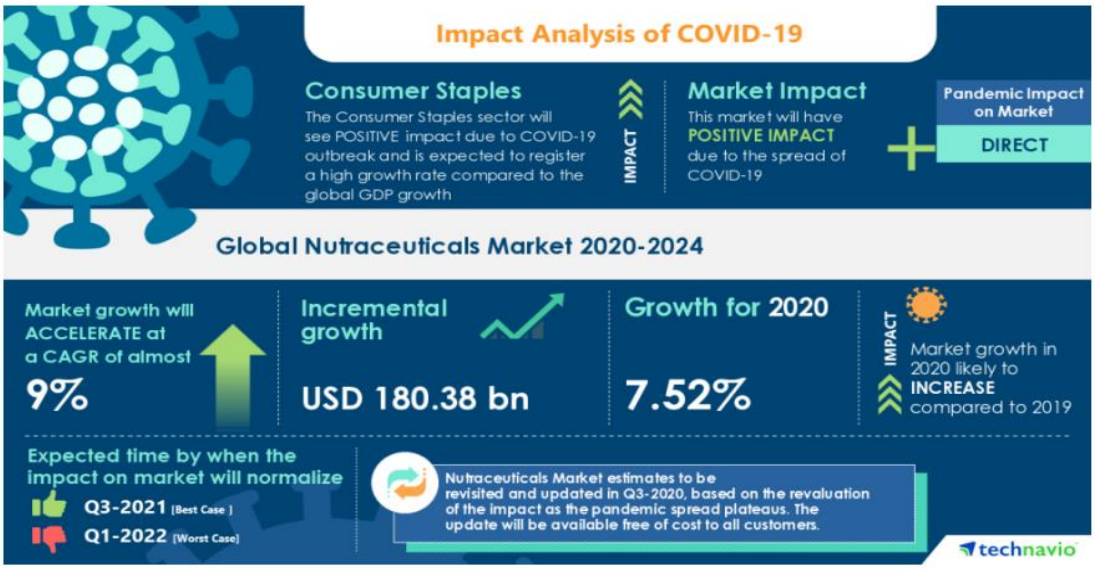

Figure 4: Shows the impact of Covid-19 on the market

Future prospects of Nutraceuticals Market

India is one of the countries where the market of nutraceuticals and dietary supplements are growing enormously. Due to COVID-19 pandemic, nutraceutical become part of consumer's daily diet and increase the demand

of nutraceuticals ingredients. In recent years, Nanotechnology has been introduced in nutraceutical industry, which has tremendous potential to revolutionalize the nutraceuticals market. With increasing health awareness and the shifting towards the preventive health care and increased regulatory clarity, India's future in nutraceuticals industry looks promising. It has great potential and is expected to grow at a growth rate of 16% year on year for the next five years. In the upcoming 10 years, the Nutraceuticals industry has potential to grow up to the size of $25-30 billion dollars (Choi et al., 2009; Wu et al., 2015).

Conclusion

Expensive treatment have paved the way for nutraceuticals as an alternative to expensive drugs that are assumed to increase in the near future. Following the pandemic and the consequent lockdown across the globe, health consciousness among people has mounted significantly, leading to a higher demand for products that boost the immunity. Vitamin supplements such as zinc are in huge demand, as these can help patients with reduced respiratory tract infections like SARS-CoV-2.It plays a big role in the body's immune function and can potentially bring down COVID-19 replication. Next few years, there has been a sharp rise in vitamin deficiencies because of the growing prevalence of hectic lifestyle, shorter meal time and nutrition loss during cooking as well as food processing. Therefore, consumers are becoming more aware of different deficiencies and the type of vitamin supplements to take, leading to a faster growth rate of the global nutraceuticals market.

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