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**OBESITY ASSOCIATED DEPRESSION: THE POTENTIAL OF *COCOS
NUCIFERA* WATER AS AN ANTIDEPRESSANTS IN OBESE
POPULATION**

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ABSTRACT

The obesity and depression illnesses affect millions of people all over the world. Obesity is the significant root cause of preventable condition globally, and depression is primary root causes of a cluster of disorders. Depression and obesity have economical, genetic, and neurological connections. Coconut water is frequently investigated for its anti-obesity and antidepressants potential in current times. The conventional medication for the treatment of depression primarily uses pharmaceutical medicines and surgical procedures, which results many adverse effects. As a result, the current analysis focuses on the use of coconut water with biological active ingredients and its action as an antidepressant. Utilization of Coconut water is due to its unique biological roles such as preventing cardiac disease, boosting digestive function, regulating cholesterol level, lowering lipid, and preventing malignancy etc. In this review, we discussed the therapeutic benefits of Coconut water, Physiochemical and biochemical compound analysis, and the effective treatment and management of depression and obesity.

**Keywords: Depression, Obesity, Coconut water, Nutritional benefits, Treatment, and
diagnosis**

INTRODUCTION

Depression is one of the most notable contributors to worldwide health issues, influence approx. 264 million people globally, accompanying acceleration of self-destruction and all dimensions of human life in public and private health [1]. According to the World Health Organization, depression was the third leading etiology of illness significance in 2008 and will be the apex in 2030 [2]. In France, depression is a common circumstance with a 7% annual prevalence, impacting 4 million individuals, and obesity has a 15% prevalence, affecting 9 million people [3]. The age standardized prevalence of depression in South Asia was 3.9%, 3.7% in Bhutan, 4.4% in Bangladesh, 4.0% in Nepal and 3.9% in India in 2016 [4].

Obesity is one of the world's most significant health concerns, caused by a variety of variables including heredity, social determinants, lack of exercise, nutrition, lifestyle, infectious agents, and the environment [5-8]. It is also considered that this metabolic condition is caused by an excessive intake of calories and fat, as well as a continuous drop-in physical activity. Peer victimization, teasing, body dissatisfaction may mediate the interaction between depression and obesity [9].

Coconut (*Cocos nucifera*) is an arid fruit tree, perennial of Arecaceae family, and in India is also known as "kalpavriksha". Coconut is also referred by many different names in Nigeria, including 'Agbon' in Yoruba, 'Mosara' in Hausa, and 'Ukpu' in Uzebba. This fruit is commonly used in foods and beverages. It is considered to be one of the most widely utilised natural substances in the world [10, 11]. The coconut plant has socioeconomic advantages. The coconut tree is one of the most productive because of the several commodities it yields, like coconut (oil, milk, water, juice) [12]. Coconut water is the fluid that comes from the kernel extracted from immature coconut [13].

Coconut water is a tasty and healthy refreshment that is extensively intake because of its advantageous health properties all across worldwide and is widely available in many tropical nations [14]. Coconut water has been linked to numerous health advantages because it includes electrolytes, vitamins, sugar, protein, antioxidants, growth hormones, amino acids, minerals, cytokinins, and dietary Fiber. Each coconut has approximately 500 ml to 1000 ml of liquid. According to the survey, coconut water was widely consumed (99%) and frequently utilised for its strengthening (33.33%) and refreshing (28.34%) results.

The growing body of scientific evidence supports its engagement in the medical and health domains. It has a high level of saturated fat and MCFA. Medium chain fatty acids easy taken in, breaks down by the cells of liver, and transform to ketones. Ketones serve a crucial function as strength source in the central nervous system and in cases of memory impairment [15].

Coconut water reduces oxidative stress by scavenging free radicals. It is natural, less expensive, and has no adverse consequences [16]. Drinking coconut water has been used to treat scorching urine suffering, burning ophthalmalgia, gastroenteritis, dyspepsia, hiccups, and even the removal of a placenta. Coconut water was used as a temporary therapy in remote places of the world and during World War II. Coconut water has been shown to rise exercise presentation, relief laxatives break down renal stones and improve renal function, bring down edema, lessen the risk of cardiac disease, and improve high density cholesterol levels. Utilization of tender coconut water aids in the prevention of Alzheimer's disease pathology and prevents osteoporosis in experimental animals. It also helps to balance body chemistry and fight cancer [17]. The objective of this study is to review the nutritional

benefits of coconut water as well as treatment of obesity and depression with coconut water.

Depression types, cause, and adverse effects

Depression is one of the common frequent psychiatric diseases, and it is sometimes associated with bipolar illness [18]. There are two types of depression: state depression and trait depression, as well as severity and intensity of symptoms. It could be due to the emotionally demanding, unexpected, and uncontrollable character of abuse [19]. Mood difficulties, reduced motivation, discrimination, fear of seizures, loss of happiness, feelings of guilt, interrupted food, interrupted sleep, and disturbed concentration are some of the symptoms of depression. Depressed mood, negative feelings towards oneself, loss of gratitude, crying spells, pessimism, loss of mirth response, loss of emotional attachment, libido decline, tenacity, sadness depth, negative expectations, self-criticism, self-blame, distorted self-image, suicidal thoughts, paralysis of will, indecisiveness, delusion, and worthlessness [20-23].

Diabetes, coronary heart disease, cardiovascular disease, and cancer are all caused by a high level of depression. Environmental changes, obesity, bad eating, cancer, insufficient physical activity, unsuitable light, and a lack of sleep are all

probable factors contributing to the rising prevalence of depression [20]. According to a Chinese epidemiological survey, depression disorder has reached 3.4%, resulting in a dangerous psychological condition that threatens the physical and mental health of the people [24]. Low economic status, unemployment, catastrophic life events, poor mental and physical health, disability, social isolation, problems with alcohol or drug consumption, and relocations many times lead to depressed state of mind [25-27].

Changes in neurotransmitters in the brain such as norepinephrine, serotonin and dopamine have been linked to depression [28]. A poor diet has been linked to the occurrence of depressive symptoms [29]. Low levels of omega-3 fatty acids, zinc, iron, folate, vitamin B₁₂, and selenium are more common in depressed people than in non-depressed people [30]. Recently, the COVID-19 epidemic has been linked to depression, and the consequences, such as quarantine, lockdown, and social isolation, are major causes of sadness [31, 32]. The prevalence of depression in girls with obesity or a metabolic disease range from 12% to 21% [33, 34].

Depression among patients with obesity in urban and rural settings

Depression and obesity are two major medical diseases that have both

physical and psychological consequences. Both depression and obesity develop through bidirectional epidemiological, clinical, and biological pathways, determinants poor health habits, shared biological disruption (HPA axis dysfunction, hormonal disorders, brain disorders, gut-brain microbiota axis issues), and psychological factors (such as trauma) [35, 36]. According to Diagnostic and statistical Manual of Mental disorders (DSM-4) and International Statistical Classification of Diseases (ICD-10), to be diagnosed with major depression, either a sad mood or a lack of interest or pleasure must be present [37]. Depression jeopardises one's quality of life and well-being [38]. The Patient The study includes 1,045,682 participants identified as inpatients and outpatients in a national hospital database with an ICD-10 code for obesity and depression. It was found that 707,680 obese patients and 338,002 patients diagnosed with depression,

Major urban with 61.03% (depression) 56.55% (obesity) & Rural area with 9.85% (depression) & 10.98% obesity respectively [39]. Health Questionnaire (PHQ) is a tool for making standard recognition of common depression and mental disorders. PHQ-9 category as the independent fluctuations, with age, gender, education, and number of physical impairments, etc [40, 41].

The PHQ-9 mark was classified as severity categorization in most analyses: 27-20 (Severe Depression); 19-15 (Moderate Severe Depression); 14-10 (Moderate Depression); 9-5 (Mild Depression); 4-0 (Minimal Depression) respectively. These categories were selected for a variety of reasons. The first was pragmatic and second was empiric, variable associations between enhancing PHQ-9 severity and determine of validity [42, 43].

Depression leads obesity/disorder eating pattern

Obesity is linked to serious depression and is more prevalent in people with low socioeconomic levels. Environmental factors may influence a genetic susceptibility. They occur concurrently, and the prevalence of serious depression is believed to be 10% [44, 45].

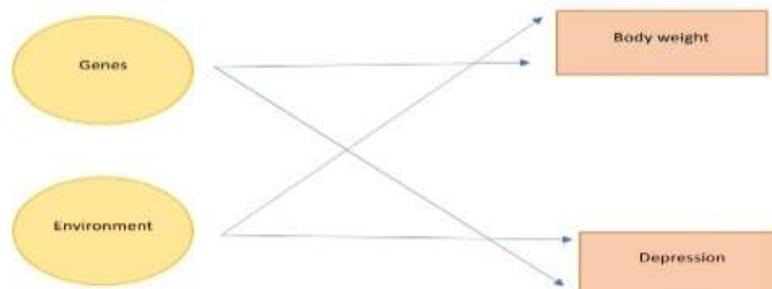


Figure 1: Representation of “environmental correlation” and “genetic correlation” linking depression and obesity

Adolescent obesity evoked mocking, which in turn provoked melancholy due to their heightened unhappiness with their looks. Everyone has seen the consequences of teasing on people’s confidence and self-esteem and has dealt with this issue in their own lives. Obese people have been subjected to verbal abuse throughout childhood, and the repercussions have been proven by the much higher rate of depression in obese people [46].

Disordered eating moderate the interplay like binge eating and the related sense of unmanageable eating exacerbate

depression. Binge eating disorder (BED) is defined as a “recurrent series of eating episodes associated with subjective and behavioural indicators of disordered control over and significant distress about binge eating without the presence of inappropriate compensatory behavior” [47, 48]. In comparison to 18% of non-eating problem obese adults, 44% of night eaters had record of major depressive disorder. Night eating syndrome (NES) patients possibly more likely to suffer from depression because of their abnormal eating habits [49].

Stress's act on the hypothalamic-pituitary-adrenal axis, including one physiologic method by which it results both depression and obesity. In depression, triggering of the HPA axis seem to be responsible for minor but statistically remarkable correlations connecting abdominal body fat and depression [50]. The socioeconomic risk and social-demographic factors for comorbid obesity and depression-related health disorders have significant public health consequences [51-53]. There is evidence to indicate biological (genetic) and behavioral (psychological) linkages between depression and obesity [54-56].

Diagnosis and treatment

An expert psychiatrist will make a diagnosis criteria based on the Statistical Manual of Mental Disorders and Diagnostic. A meta-analysis examined the impact of exercise on various aspects of quality of life (QoL) in patients suffering from depression. Exercise may be used to cure depression [57]. The electroencephalogram (EEG), a non-interfering functional neuroimaging technology, has been utilised to investigate relevant biological markers for the Depression disorder's identification. Deep learning (DL) techniques based on architectures and networks as well as classic approaches based on machine learning (ML)-based algorithms,

are used for EEG-based depression detection [1]. Women are double as likely as male to suffer from depression, especially during their reproductive years [55]. The monoamine oxidase inhibitor class of antidepressants delays the usual enzymatic breakdown of these neurotransmitters. Another class of drugs known as monoamine reuptake inhibitors limits the normal recapture of 5-HT and noradrenaline by preventing their passage back into the presynaptic nerve terminal [58]. **Treatment of obese patients with depression**

The goal of treatment is to minimise depressive symptoms in order to avoid suicidal imagination, relapse, and assist patients in developing the skills necessary to live with their disability or psychosocial trouble, if applicable. To improve function as depressive symptoms fade, behavioural rehabilitation should be paired with antidepressant medication [59]. Obesity treatment frequently results in a reduction in depression. Cognitive-behavioural therapies (CBT) for depression have been demonstrated to be beneficial for a wide range of people.

Another sort of quick treatment for depression is electroconvulsive therapy (ECT), sometimes known as electroshock therapy [60]. Pharmacotherapy and psychotherapy have small to modest treatment

results, with one-third of population with depression remaining no effective to therapy. Pharmacotherapy can also have a number of negative side effects, such as headaches and nausea. Physical comorbidities connected with depression are also unaddressed by medicine and psychotherapy. Psychotherapy and Pharmacotherapy play vital roles in depression treatment in the upcoming time [61-65].

Nutritional benefits of coconut water

Plants are frequently studied for their antidepressant properties in modern times. Monoamines show that young coconut water has an antidepressant effect. HPLC-electrochemical identification of noradrenaline, dopamine, and 5-hydroxytryptamine in rodent brain revealed a decrease in the following 3,4-dihydroxyphenylacetic acid, 5-hydroxyindoleacetic acid. Coconut water is a naturally produced fluid replacement that is high in sodium chloride, potassium, and carbohydrates [66]. It can help with obesity, dyslipidemia, increased LDL, insulin resistance, hypertension, CVD, and type 2 diabetes [11, 14, 16, 67, 68]. Coconut water is used to dissolve bladder stones and treat

gastroenteritis [69, 70]. Coconut water has a high osmolality due to the sugar content, which is largely fructose and glucose in immature coconut and sucrose in mature coconut respectively. It also contains a high concentration of vital amino acids such as phenylalanine, lysine, leucine, histidine, and tryptophan [10, 67]. Coconut water composition depends on various factors like nut maturity, climate, variety, and soil. Its waste is rich in growth hormones, auxin, and cytokines (growth promoter hormones) [71]. **Table 1** shows the constituents, concentration, and nutritional benefits of coconut water [72-74].

Physiochemical and biochemical compound analysis of coconut Water

The proximate composition of Coconut water shows 4.98 ± 0.18 pH, $0.42 \pm 0.00\%$ Ash value, $0.335 \pm 0.02\%$ Fat content, $0.291 \pm 0.00\%$ protein content, $0.018 \pm 0.00\%$ crude fiber content, 0.05 ± 0.00 Mineral content and phytochemical compound analysis. **Table 2** shows the different characteristics of coconut water at various parameters and independent measurements [72].

Table 1: Constituents, Concentration and Nutritional benefits of Coconut water

| Constituents (Coconut water per 100ml) | Concentration (v/v%) | Nutritional benefits |
|--|----------------------|---|
| Calcium | 0.4% | Antioxidants property and maintain fluid equilibrium. |
| Potassium | 3.05% | Regulate blood pressure, energy production, bone building, fluid regulation and muscle contraction |
| Magnesium | 0.16% | Reduce sugar level (blood) in people with type 2 diabetes and pre-diabetes. |
| Total reduced sugar | 40.25% | Nutrient-beverage |
| Total protein | 0.15% | Build Muscle, reduce obesity, boost immune system |
| Polyphenols | 0.003% | Protect against cardiovascular disease, osteoporosis, diabetes, neurodegenerative diseases and development of cancer. |
| Sugar | 48.81% | Energy source |
| Protein | 0.291% | Help bio-enzymes, building muscle |
| Flavonoids | 0.382% | Anti-inflammatory, Antioxidant |
| Carbohydrate | 4.38% | Hydration, prevent kidney stone, manage obesity, regulate body temperature, support digestion, boost energy. |
| Dry matter | 5.09% | Lower blood pressure, help to lose weight |
| Fat | 0.335% | Better oral health |
| Vitamin (Riboflavin, thiamine) | 0.0013% | Help in Depression and Stress |

Table 2: Analysis of Coconut water

| Parameters | Instrument/Method | Characteristics |
|---|---|---|
| pH | pH-meter | 4.98±0.18 |
| Ash value | AOAC method | 0.42±0.00% |
| Fat content | Liquid liquid extraction method | 0.335±0.02% |
| Protein content | Kjeldahl technique | 0.291±0.00% |
| Crude fiber content | AOAC method | 0.018±0.00% |
| Mineral content | Atomic absorption Spectrophotometer | 0.05±00 |
| | Phytochemical Compound | |
| Total Phenols | Folin-Ciocalteu colorimetric technique | 0.177±0.001 µg/ml GAE (Gallic acid equivalents) |
| Total Flavonoids | Alcl3 colorimetric method | 0.381±0.010 µg/ml QE (Quercetin equivalents) |
| Antioxidant Activity | 2,2-diphenyl-1-picryl-hydrazyl (DPPH) assay | 15.84±1.76% AA (Rate of scavenging activity) |
| Microbiological analysis (Aerobic mesophilic germs) | Plate count Agar (PCA) | 1±0.6 UFC/mL (Colony forming unit) |

Antidepressant Action by Coconut Water

Coconut oil also tends to raise tryptophan levels, an amino acid that acts as a precursor to serotonin, increasing mood and combating psychological diseases including depression. The lauric acid in coconut oil might also improve one's mood. It accomplishes this by increasing dopamine

levels in the brain. It is anti-inflammatory, antimicrobial, antibacterial, rejuvenating, and diuretic. Coconut water has potential on stomach dysfunction, and dysentery, as well as anti-diabetic, anti-hyperlipidemic, and digestive system-beneficial properties [10, 75]. Coconut boosted locomotor activity [76]. Depression is a common finding in health care

disciplines. This mental disorder affects millions of people worldwide. Plants are commonly used as antidepressants, according to several studies [77, 78].

Coconut water reduces obesity

Green coconut water reduces cholesterol levels with good efficiency. The current population supports the slogan “Back to Nature”. Adipocyte differentiation and lipid accumulation, including triglycerides, in 3T3-L1 cells due to its bioactive components are effects of coconut water. Aromatic coconut water can modestly reduce lipid accumulation [79]. *Lentinus strigosus mycelis* (grown in submerged culture) is an addition to functional resources that contains microchemical such as atherone, coumarins,

anthraquinones, flavonoids, alkaloids, terpenoids, steroids, phenols, saponins, and flavonoids, that play vital roles in various mechanisms of anti-obesity activity. Saponins and terpenes prevent obesity by decreasing the action of pancreatic lipase [80-84]. In rats fed high-fat and high-fructose diets, coconut water was able to diminish adipose tissue mass by triggering metabolic activity via attenuation of leptin levels. Coconut water can mitigate the adverse effects of a high-fat mother's diet during pregnancy on the young one's reproductive capabilities. It mitigates the effects of maternal high-fat diets on children [85-87]. **Table 3** shows the different pharmacological activities of coconut water [89].

Table 3: Pharmacology Activities of Coconut water

| Diseases | Pathway | Phytochemicals | Mechanism |
|-------------------|--|---|--|
| Antidiabetic | L-arginine-nitric oxide pathway | Fiber, potassium, manganese, magnesium, vitamin C, and L-arginine | Mature coconut water and L-arginine reduce the concentration of blood glucose, serum creatinine, uric acid, and HbA1c and increase the level of total protein [67, 88]. |
| Anti thrombotic | L-arginine-NO pathway | Amino acids, L-arginine, and Vit C | Reduces level of WBC, platelet, fibrin, and fibrinogen [67] |
| Antioxidant | Scavenging ability of free radicals likes superoxide, singlet oxygen and hydroxide radicals. | Polyphenols, flavonoids, carbohydrates, proteins, and tannin | Ferric thiocyanate radical scavenging, thiobarbituric acid assay, nitric acid (NO) radical scavenging, and beta-carotene bleaching assays [89-91]. |
| Anti-inflammatory | AKT and JNK signaling pathway | Vitamin C and flavonoids | Increase SOD activity, elevation of inflammatory cytokines, and nitric oxide production [92]. |
| Cardio protective | Decrease free radicals' formation. | Mg | Increased activities of creatine phosphokinase (CPK), serum glutamate pyruvate transaminase (SGPT). There was a decreasing concentration of TC, HDL cholesterol, and LDL cholesterol in the serum of isoproterenol [93]. |

CONCLUSION

Depression and obesity are prevalent clinical situations that are linked to a wide range of health hazards and have a synergistic negative impact on the progression of both disorders, therapy response, and quality of life. Obesity and depression often coexist in patients, with significant societal health implications. Obese people are generally susceptible to depression, and 43% of depressed adults are obese. Because of its refreshing, digestive, and strengthening impacts, high mineral content, and bioactive substances with therapeutic capabilities, coconut water is widely used as a healthy beverage. Coconut water responds to a variety of health issues like digestive disorders, infections of the urinary system (UTI), depression, kidney stones, Cardio protective activity, diarrhea therapy, as well as acting as an anti-inflammatory, anti-diabetic, antithrombotic, anti-uropathogenic, and anti-infection agent. Coconut water is a well supplier of ions (chloride and potassium), and its utilization could be recommended in instances where these electrolytes are depleted. Obesity and depression should be reduced in the population through prevention and education activities. Coconut water is a better way to treat a mix of diseases such as depression and

obesity while also supporting the environment and promoting a healthy society.

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Conflict of Interest

The authors declare that they have no potential conflict of interest to declare.

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