Research & Reviews: Journal of Food and Dairy Technology

e-ISSN:2321-6204
p-ISSN:2347-2359

Foods Responsible for Improving our Mood

Kate PE*, Deshmukh GP, Datir RP and Jayraj RK

ICAR-National Dairy Research Institute (Southern Regional Station), Bengaluru, India

Review Article

Received Date: 13/06/2017
Accepted Date: 21/06/2017
Published Date: 28/06/2017

***For Correspondence**

Kate Parameshwar Eknath, ICAR-National Dairy Research Institute (Southern Regional Station), Bengaluru, India, Tel: +91 8147208662.

E-mail: paramkate@gmail.com

Keywords: Mood, Serotonin, Dopamine, Tryptophan, Peptides, Mood foods

ABSTRACT

Mood is a complex human mental situation which fluctuates depending on several central, peripheral biological and other extraneous factors including food. Basically, good mood or bad mood is a result of certain chemicals influencing the neural response. Some foods have proved to be mood enhancers by getting desired neurotransmitters released in brain and also by stress relieving. Bioactive factors like peptides, probiotics, macronutrients like carbohydrates, amino acids, minerals, blood sugar levels, vitamin supplements etc. have been reported to exhibit mood enhancing property. Foods like chocolate, ice cream, cold and hot beverages are known to improve the mood and are recommended for healthy individuals. Hence, good mood foods are likely to create niche market themselves in future. Foods specifically targeted at affecting mood, mental health, depression, or cognitive function (i.e., "Mood Foods") represents a relatively new area of interest to the food industry.

INTRODUCTION

Mood is considered as an emotional state and may be defined as one's mental status of thinking and behaviour in a healthy, normal individual. Good mood is usually considered a state without an identified cause people cannot pinpoint exactly why they are in a good mood. Apart from several extraneous factors, foods that we relish and consume have a great impact on it. It is often said that human endeavour is first to fulfill his culinary desires and rest all comes only after that. This probably has led to discovery of hundreds of varieties of foods that we consume today. It is common experience that foods that we like enhance our 'mood' and those that we detest spoil the 'mood'. This actually is the result of nerve reactions elicited by the food compounds and release of chemicals that stimulate the nerve reactions [1].

Good Mood

People seem to experience a positive mood when they have a clean slate, have had a good night sleep, and feel no sense of stress in their life [2]. For this state, balance of certain chemicals called neurotransmitters, made up of amino acids, in human brain is responsible. Depending on the type of neurotransmitters, these can act as stimulants of nerve reactions creating excitement, motor movement and higher thinking, promote alertness, energy and activity. Examples of compounds of this category are: dopamine, oxytocin, serotonin, and endorphins. Each one is activated in a different way. By designing daily experiences that activate these chemicals, one can increase one's happiness and productivity. The principal means by which neurons affect each other is via their neurotransmitters [3].

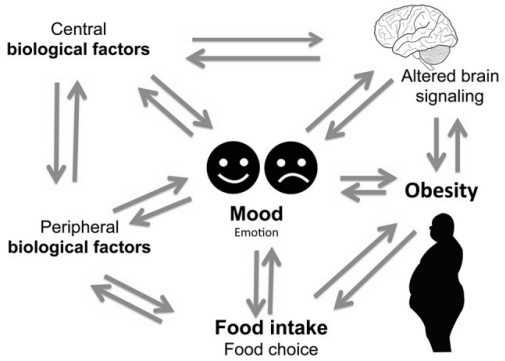

Figure 1. Interaction between factors influencing 'mood'. Source: Singh [4].

e-ISSN:2321-6204
p-ISSN:2347-2359

Bad Mood

Other category of neurotransmitters like GABA (gamma-amino butyric acid) acetylcholine and taurine [5] can do opposite of these, that is, act as the body's natural tranquilizers, generally serving to induce sleep, promote calmness, and decrease aggression, entailing decreasing 'mood'. In the presence of danger and in unfavourable and disliking conditions, the 'bad feeling' chemical – cortisol – is produced. Clinical depression is caused by a chemical imbalance in the brain, and this is what most drug treatments are based on. In many cases, there is a reduction in the amount of certain neurotransmitters found (monoamines such as norepinephrine) in depressed people [6]. There are several other factors which affect human's mood and human being always tries to enhance his / her mood by various ways [7].

Thus, in a healthy individual, excitory neurotransmitters enhance 'mood' and inhibitory neurotransmitters depress 'mood'. Foods that we consume can alter the release of these neurotransmitters. 'Mood' is therefore likely to result from the interaction of multiple, semi-independent, neural circuits working together in harmony **(Figure 1)**. Most of the individuals when feeling depressed moods show more preference for the consumption of palatable "comfort foods" to dominate their negative feelings [8]. Although on a short-term basis, palatable foods can provide temporary relief from negative emotions and mood states, chronic consumption of calorically-rich foods ultimately leads to obesity which in turn promotes vulnerability to depression and anxiety [9-11]. Human mood is a actually a response of our nerves and brain to a set of complex chemicals released into blood as a result of several intrinsic and extrinsic factors, including foods we consume.

Foods as Mood Enhancers

The nutrients in foods are precursors to neurotransmitters. Depending on the amount of precursors present in the food we eat, the more or less of a certain neurotransmitter is produced. Different nutrients interact will also impact the production and release of neurotransmitters. Thus it can be said that foods we consume also have influence on the type of neurotransmitters produced and their quantity [12]. When a question was asked to the people, what's the thing to do when you are feeling depressed, she found that around 34% people preferred to eat something when they felt depressed and some pleasant activities like alcohol consumption [13].

Fluctuations in blood sugar levels are also associated with changes in mood and energy, and are affected by what we eat. **Figure 2** shows the relationship between Mood, Food choice and Functional food product development requirement source [14].

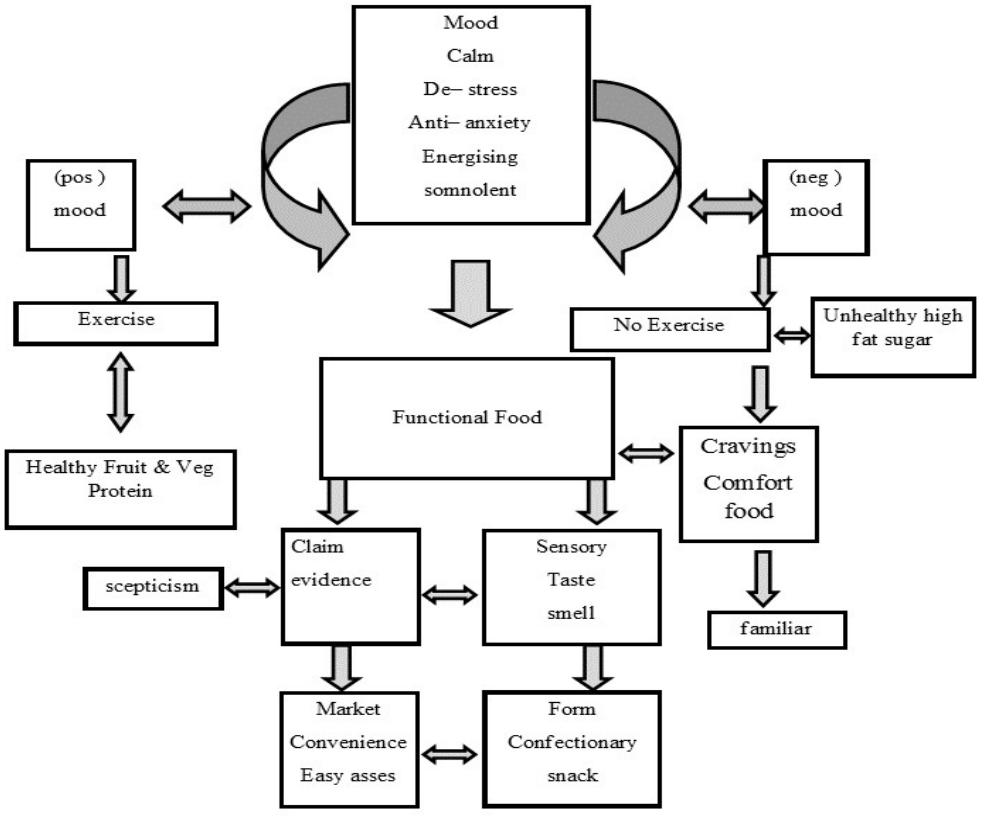

Figure 2. The relationship between mood, food choice and functional food. Source: Williams's et al. [14].

Some nutrients and bioactive factors in generally available foods are as follows; Neurotransmitters, dietary amino acids, caffeine, lipid, carbohydrates, chocolate, vitamin, mineral, alcohol, exorphins, biogenic amines (crucial for mood)

e-ISSN:2321-6204
p-ISSN:2347-2359

[(serotonin, norepinephrine (NE), dopamine (DA)]. Amino acids: gamma-amino butyric acid (GABA), glutamic acid, glycine (coagonist of glutamate), and N-methyl-D-aspartic acid (NMDA), and peptides - encephalins and endorphins [15].

Carbohydrates, Sweets and Brain Function

Insulin plays an important role in the assimilation of carbohydrates including glucose. It also simplifies the process of transferring essential amino acids from blood into the cells. Tryptophan in the blood rises, which facilitates its penetration through the blood–brain barrier into the CNS (central nervous system). It is the basic material in the synthesis of the serotonin neurotransmitter in the brain. Eating sweets causes release of endogenous opiates which have influence on human mood and the ability to calm down.

Some studies have been reported on foods we consume and 'mood'. Harris et al. [16] conducted a study wherein two groups of obese individuals who consume excessive calories primarily as snack foods have been identified. Carbohydrate cravers consume most or all snacks as carbohydrate-rich foods despite the equal accessibility of protein-rich snacks. Non-carbohydrate cravers consume about equal amounts of protein- and carbohydrate-rich snack foods. Using standardized self-report questionnaires, they measured mood before and two hours after consumption of a high-carbohydrate lunch (104 g carbohydrates). Responses to the meal differed significantly: non-carbohydrate cravers reported feeling considerably less alert, more fatigued and sleepy, while carbohydrate cravers described little or no change in these aspects of mood. Moreover, non-carbohydrate cravers experienced an increase in depression, while carbohydrate cravers reported feeling less depressed. Findings suggest that snacking habits of obese individuals may be related to subsequent mood states.

Changes in serotoninergic neurotransmission may be responsible, in part, for these alterations in mood observed after carbohydrate consumption. Carbohydrate ingestion increases the brain's uptake of tryptophan, the amino acid precursor to serotonin, thereby enhancing brain serotonin synthesis and release. When sufficient amounts of protein are consumed along with the carbohydrate, these increases are prevented from occurring. Serotoninergic neurons have been reported to participate in sleep, mood, and pain sensitivity and it has been suggested that a deficiency in serotonin release may characterize some depressive illnesses. The almost exclusive consumption of carbohydrate snacks by carbohydrate cravers would presumably increase brain-serotonin synthesis for a few hours (i.e., for as long as the plasma-tryptophan ratio was elevated). The consumption of both protein and carbohydrate snacks by non-carbohydrate cravers would fail to produce such an increase. The purpose of this study was to determine whether the usual snack choices of these obese individuals [16].

The relationship between mood and carbohydrate cravings, and the possible role of gender in these associations, was investigated by Christensen et al. [17]. Selected individuals classifying themselves as "carbohydrate cravers" reported foods rich in carbohydrates, and "protein cravers" reported protein-rich foods as being the ones they most strongly craved. Carbohydrate cravers reported feeling distressed prior to their cravings and satisfied, happy/good and relaxed following carbohydrate consumption. Protein cravers reported feeling anxious or hungry prior to their cravings and happy, normal, bored, and energetic following protein-rich food consumption [17].

Meal almost exclusively carbohydrates increase the availability of tryptophan and hence serotonin synthesis in the brain, however, a small amount of protein blocks this mechanism making it an uncommon response. In many individuals, poor mood stimulates the eating of palatable high carbohydrate/ high fat foods that stimulate the release of endorphin. There is a tendency for those with lower blood glucose, when performing cognitive demanding task, to report poorer mood [18].

The Effect of Lipids on Mood

Fats, especially unsaturated fatty acids omega-6 and omega -3, are very significant in the diet because they build the neuron membranes. The brain and nervous tissue membrane lipids contain a particularly high proportion of arachidonic acid (AA) and docosahexaenoic acid (DHA) and low concentrations of their 18-carbon precursors.

It suggests that flax seeds contain emotion-boosting omega-3 fatty acids. Flaxseed oil provides a number of benefits for mood and brain functioning. Sunflower seeds are rich in vitamin E, selenium, magnesium and also contain tryptophan which promotes relaxation, calm the brain and relieve tension [19].

NEUTRAL AMINO ACIDS

Tryptophan

The amino acid that has been shown to affect brain neurotransmission most readily is tryptophan. It is an essential amino acid and precursor of neurotransmitter serotonin and hormone melatonin. Central serotoninergic system is also involved in the regulation of other mood status, including depression. However, a single tryptophan deficient meal has been clearly shown to produce transient depression in normal human. It produces hypnotic like effect, accordingly, it could be considered as a drug not a food.

Tyrosine

Tyrosine is a precursor of several neurotransmitters like catecholamine, dopamine, norepinephrine and epinephrine.

e-ISSN:2321-6204
p-ISSN:2347-2359

It has been shown to reduce adverse effect of tail shock, cold stress, and hypoxia (deficiency in the amount of oxygen reaching the tissues). Thus it may be said that protein and carbohydrate foods may affect behaviour.

Another group of neurotransmitters associated with depression and lack of motivation are the catecholamines - dopamine, noradrenaline and adrenaline. As shown in **Figure 3**, both adrenaline and noradrenaline are synthesized from dopamine, which is made from the amino acid tyrosine, which is itself made from the amino acid phenylalanine. It is logical to assume that, if the drugs that block the breakdown of these neurotransmitters do elevate mood, then augmenting the amino acid phenylalanine or tyrosine might work too. **Figure 3** illustrate the catecholamine pathway [20].

Mineral Components Important for Mood

Depression is not a homogeneous illness, and one of its primary symptoms is mood lowering. An anti-depressant effect can be observed after patients are given microelements such as zinc, lithium, and rubidium [21]. Lithium is used in the prevention of depression; it inhibits one of the serine-threonine kinases (GSK-3β) and evokes changes in the expression of genes [22].

Role of Zinc and Copper

Zinc is connected with copper in its influence on the conversion of neurotransmitters in the brain. The serum copper concentration in depression is significantly higher than in the control [22].

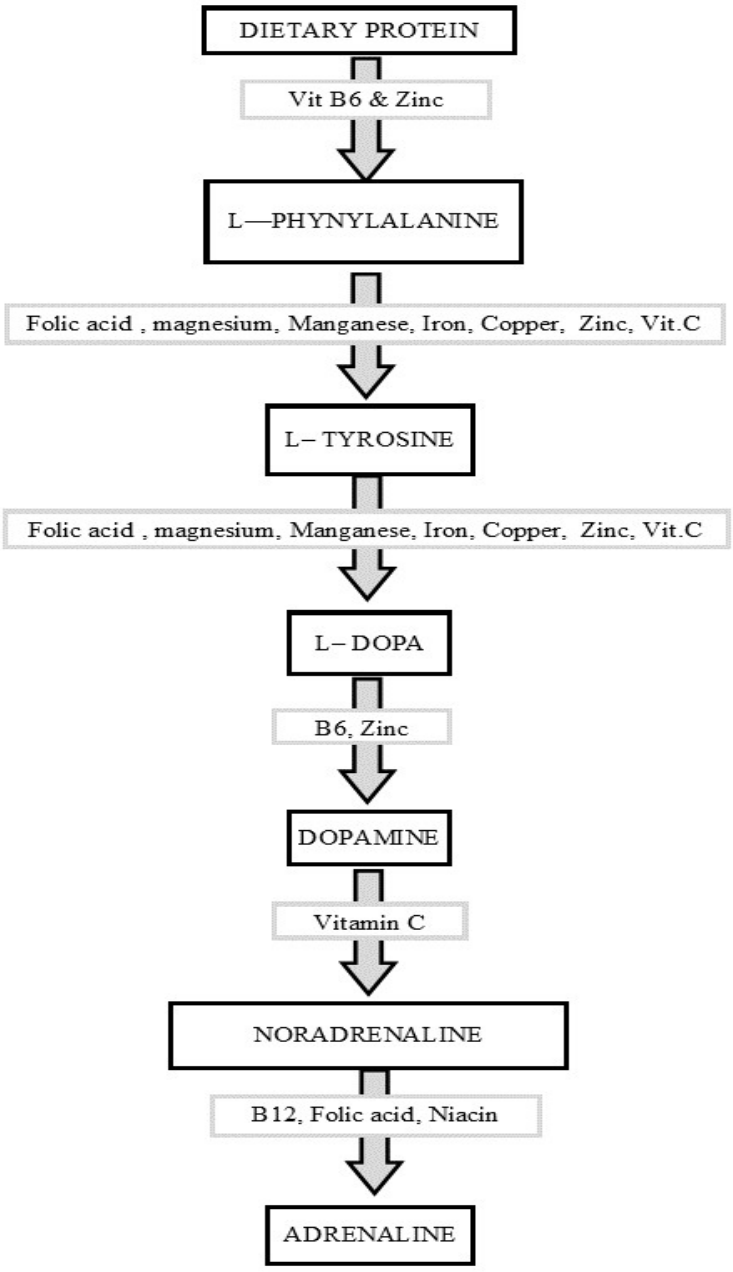

Figure 3. Catecholamine pathway. Source: Holford [20].

e-ISSN:2321-6204
p-ISSN:2347-2359

The Role of Selenium

Selenium status also modifies mental functions. A low selenium status leads to depressed mood, while high dietary or supplementary selenium improves the mood [23]. Low selenium status is associated with a significantly increased incidence of depression, anxiety, confusion, and hostility, and with senility and cognitive decline in elderly people. **Figure 3** illustrate nutrients that make mood-enhancing neurotransmitters [20].

Alcohol and Mood

Drinking alcohol, in most cases, is associated with inducing positive feelings like pleasure or a reduction of negative feelings like uncertainty and tension. Sometimes, it can lead to an increase in negative emotions or can have no direct effects on mood at all [24]. **Table 1** shows extent of drinking and amount of alcohol. Alcohol affects many mental and perceptual processes and motor skills. Consumption of alcohol influences women to a greater degree than men, in part because the same amount of ethanol produces higher blood alcohol concentrations in women. Intake of alcohol negatively affects several different physiological functions like cardiovascular system, cellular immunity and haemostasis; hence, alcohol should be consumed in only small doses (ADI 60 ml/day). Such foods can improve mood and mitigate effects of stress via brain opioidergic and dopaminergic neurotransmission, and in vulnerable (stressed) people via enhanced function of the serotonergic system [25]. Unfortunately, behaviours such as overeating, smoking or drinking alcohol that serve to alleviate stress in the short term can create significant health problems in the long run, such as obesity, cancers, heart disease and diabetes [26].

Table 1. Definition of drinking habit.

Extent of drinking	Number of standard drinks	Amount of alcohol
Light drinking	Between 1 and 7 a week	Up to 70 g
Moderate drinking	7-28 drinks/week for men	70-280 g for men
	7-21 drinks/week for women with no heavy sessions	70-210 g for women
Heavy drinking	More than 5 or 6 drinks/day and/or heavy drinking sessions	Over 65 g per day

Exorphins

(Exo = exogenous or from outside, orphin = morphine, an opium) The opposite of endorphins, are a family of food derived peptides that act on brain receptors. When pepsin acts on casein, it generates many peptides, some of which interact with opium receptors in the brain; these peptides are known as casomorphins [27]. It is a natural anti-depressant. Many peptides that come from gluten (a wheat protein), zein (a corn protein) and casein and act as opium antagonists, which, in addition to being appetite suppressants, affect a variety of other central nervous system functions, including mood [28].

Aroma and Taste

A good aroma can also be a mood enhancer [29]. For example vanilla aroma and flavour from an ice cream or citrus aroma from a beverage may induce pleasant feelings and thereby enhance mood. This happens basically by the response of the neurons to the aroma compounds and the relaxation of the concussed neurons.

PHYSICAL EFFECT

Foods like ice cream, cold beverages like cold lassi and buttermilk etc. When consumed in hot weather absorb some heat from the body and relax the consumers enhancing their 'mood'. Consumers of hot beverages also feel relaxed probably because of muscle and nerve relaxation effects. Relaxation relieves pain or keeps it from getting worse by reducing tension in the muscles. It can help you fall asleep, give you more energy, make you less tired, reduce your anxiety, and make other pain relief methods work better. Some people, for instance, find that taking a pain medicine or using a cold or hot pack works faster and better when they relax at the same time. Quinian et al. [30] based on psychopharmacological studies concluded that ingestion of hot caffeinated beverages stimulates physiological processes faster than hitherto described, primarily via the effects of hot water and caffeine, but with beverage type and milk playing important modulatory roles.

Good Mood Foods and Supplements

In humans, eating behavior is complex and is affected by both mood and emotions Important among mood regulating behaviors is food consumption [31]. The interaction between mood, emotional state, and feeding behaviors is complex and it is hypothesized that individuals regulate their emotions and mood by changing both food choices and quantities [32]. Interestingly, highly palatable foods activate the same brain regions of reward and pleasure that are active in drug addiction [33], suggesting a neuronal mechanism of food addiction leading to overeating and obesity [4].

e-ISSN:2321-6204
p-ISSN:2347-2359

Chocolate

Chocolate stimulates the release of endorphins, natural hormones produced by the brain, these generates feelings of pleasure and promotes a sense of wellbeing. One of the ingredients in chocolate is tryptophan, an essential amino acid needed by the brain to produce serotonin. Serotonin is a mood modulating neurotransmitter, the brain's "happy chemical." High levels of serotonin can give rise to feelings of happiness. Further, Anadamine targets the same brain structure as THC (tetrahydrocannabinol), the active ingredient in cannabis. Thus, psychoactive substances in chocolate can be creating a true drug-like addiction. Cocoa contains a number of potentially psychoactive chemicals [34]. Tyramine and phenylethylamine, have similar function to amphetamine. Theobromine and caffeine, both are known to have stimulant properties. Caffeine may have more central-nervous-system mediated effects on alertness, while theobromine may be acting primarily via peripheral physiological mechanisms [35].

Milk and Milk Products

Milk can affect processes outside the human gut e.g., the hypotensive effect of milk bioactive peptides through angiotensin-I-converting enzyme (ACE) inhibition. Milk also contains some opioid peptides having pharmacological similarity to opium. The caseins and whey proteins are potential sources of such opioid peptides. These opioid peptides have antihypertensive and antidepressant activities. Milk also contains DHA (docosahexaenoic acid), α-lactalbumin and phospholipids, which affect mood and reduce stress [36-38].

The consumption of probiotic-containing yoghurt improved the mood of those whose mood was initially poor [39].

Ice Cream and Cold Beverages

Ice creams that are rich in protein increase the odds of boosting tyrosine levels in the brain. Tyrosine is a neurotransmitter that raises dopamine and norepinephrine levels [40]. Cold lassi and buttermilk also produce soothing effect and enhance one's 'mood'.

Coffee

It is observed that positive effects of regular coffee-drinkers on various aspects of health, such as psychoactive responses (alertness, mood change etc.). The improvement of mood is among the effects attributed to caffeine in coffee drinkers [30]. Over consumption of coffee increase caffeine content of body which suppresses the serotonin, it leads to depression. Caffeine has profound effects on sleep and wake function [41]. Regular dietary caffeine intake is associated with disturbed sleep and associated daytime sleepiness [42].

Tea

Green tea contains L-theanine. Consumption of 50 mg of L-theanine (equivalent to two-three cups of tea) has been shown to stimulate the alpha brain waves. By increasing the frequency of these brain waves, the beta brain waves which are associated with tension are decreased [43]. L-Theanine promotes relaxation without drowsiness. L-theanine is not a sedative but promotes good quality of sleep [44].

Diet

Though caffeinated drinks bolster the mood, Holford et al. [20] suggested to reduce their consumption because such diets offer only temporary relief and show adverse effects in the long run. Instead, it was suggested to increase consumption of fruit and vegetables five servings a day, fish (mackerel, tuna, salmon, and herring) twice a week and ensure sufficient protein from fish, meat, eggs, beans and lentils.

COMMERCIAL INTRODUCTIONS

Mood food continues to garner attention from manufacturers. In 2002, Scottish ice cream maker Mackie's launched a mood enhancing low calorie ice cream that was flavoured with the essence of native Alaskan orchid, claiming to make people happy. In 2006, Nestle announced an investment of about 4 million US dollar a year over a five year period to research into the relationship between nutrition and the brain. Coca-Cola introduced the omega-3 fatty acid docosahexaenoic acid (DHA) to its soy milk product Odwalla, with claims to support healthy brain development. Yakult and Unilever are also using ingredients such as GABA, phosphatidyl serene (PS), or L-theanine for their cognitive benefits. In UK, Unilever has introduced a marketing campaign that promotes the benefits of its green tea as a mood food. One of the most successful mood food products has been Ezaki stress-reducing 'Mental Balance Chocolate GABA' with first year sales of 50 million US dollar surpassing all forecasts [45].

CONCLUSION

Mood clearly impacts upon food choice and vice versa, and mood enhancement is an important function sought of food. In this competitive era people are suffering from stress, hence may opt for mood enhancing dietary items. So, the

e-ISSN:2321-6204
p-ISSN:2347-2359

demand of stress relieving foods of the society is likely to increase. While mood food is an emerging trend, this segment could be another passing fad unless these products pass the health and mood enhancing claims. A successful functional mood-altering food product should be proven to be effective in delivering benefits, safe for consumption, highly palatable, pleasant smelling, and light and small in size, clearly labelled and readily available. Familiar foods would appear to be more acceptable to the consumer as a vehicle to carry functional ingredients.

REFERENCES

1. Amanda G. The Mind guide to food and mood. Food and Mood Project. 2010.
2. https://en.wikipedia.org/wiki/Mood
3. McGeer PL and McGeer PG. Chemistry of mood and emotion. Annual Rev of Psychol. 1980;31:1-649.
4. Singh M. Mood, food, and obesity. Front Psychol. 2014;5:925.
5. Anonymous. Neurotransmitters, depression and anxiety, Kellevision. 2008.
6. Robert E, et al. Self-regulation of mood: strategies for changing a bad mood, raising energy, and reducing tension. J of Personality and Soc Psychol. 1994;67:910-925.
7. Macht M. How emotions affect eating: a five-way model. Appetite. 2008;50:1-11.
8. Novick JS, et al. Clinical and demographic features of atypical depression in outpatients with major depressive disorder: Preliminary findings from STARD. J Clin Psychiatry. 2005;66:1002-1011.
9. Simon GE, et al. Association between obesity and psychiatric disorders in the US adult population. Archives of general psychiatry. 2006;63:824-830.
10. Kloiber S, et al. Overweight and obesity affect treatment response in major depression. Biologic Psychiatry. 2007;62:321-326.
11. Ottley C. Food and mood. Mental Health Prac. 2000;3:32-39.
12. Rogers PJ. Food, mood and appetite. Nutr Res Review. 1995;8:243-269.
13. Williams E, et al. A qualitative analysis of consumer perceptions of mood, food and mood-enhancing functional foods. J Nutraceu, Func & Med Foods. 2005;4:61-83.
14. Coppen A and Bolander-Gouaille C. Treatment of depression: time to consider folic acid and vitamin B12. J Psychopharmacol. 2005;19:59-65.
15. Lieberman HR, et al. Changes in mood after carbohydrate consumption among obese individuals. The American J Clinic Nutr. 1986;44:772-778.
16. Christensen L and Pettijohn L. Mood and carbohydrate cravings. Appetite. 2001;36:137-145.
17. David B. Carbohydrate ingestion, blood glucose and mood. Neurosci and Biobehavior Review. 2002;26:293-308.
18. Shreyasi H and Khaled KL. An extensive review on the relationship between food and mood. International J Sci and Res. 2016;5:1750-1755.
19. Holford P. Depression: The nutrition connection. Primary Care Mental Health. 2003;1:9-16.
20. Koyama K, et al. Efficacy of methylcobalamin on lowering total homocysteine plasma concentrations in haemodialysis patients receiving high-dose folic acid supplementation. Nephrology Dialys Transplant. 2002;17:916-922.
21. Maria HB. Mood food. Chemical and functional properties of food components (3rd edn). CRC press Publications, Boca Raton, Florida. 2007;427-436.
22. Benton D and Cook R. Selenium supplementation improves mood in a double-blind crossover trial. Psychopharmacol (Berl). 1990;102:549-550.
23. Lloyd HM and Rogers PJ. Mood and cognitive performance improved by a small amount of alcohol given with a lunchtime meal. Behav Pharmacol. 1997;8:188-195.
24. Gibson EL. Emotional influences on food choice: sensory, physiological and psychological pathways. Physiolog and Behav. 2006;89:53-61.
25. Greeno CG and Wing RR. Stress-induced eating. Psychological Bulletin. 1994;115:444-64.
26. Teschemacher H, et al. Milk protein-derived opioid receptor ligands. Biopolymers. 1997;43:99-117.
27. Prasad C. Food, mood and health: A neurobiological outlook. Brazilian J Med and Biolog Res. 1998;31:1517-1527.
28. Warrenburg S. Effects of fragrance on emotions: moods and physiology. Chem Senses. 2005;i248-i249.

29. Quinlan P, et al. Effects of hot tea, coffee and water ingestion on physiological responses and mood: the role of caffeine, water and beverage type. Psychopharmacol (Berl). 1997;134:164-73.

30. Christensen L. Effects of eating behavior on mood: a review of the literature. International Journal of Eating Disorders. 1993;14:171-183.

31. Trivedi V, et al. Good mood food and health. Paper presented at National Seminar on Indian Dairy Industry - Opportunities and Challenges. 2015;100-104.

32. Volkow ND, et al. Food and drug reward: overlapping circuits in human obesity and addiction. Curr Top Behav Neurosci. 2012;11:1-24.

33. Gibson EL and Desmond E. Chocolate craving and hunger state: implications for the acquisition and expression of appetite and food choice. Appetite. 1999;32:219-240.

34. Mitchell ES, et al. Differential contributions of theobromine and caffeine on mood, psychomotor performance and blood pressure. Physiol Behav. 2011;104:816-822.

35. Mills S, et al. Milk intelligence: mining milk for bioactive substances associated with human health: A review. Int Dairy J. 2011;21:377-401.

36. Young SN. How to increase serotonin in the human brain without drugs. Rev Psychiatr Neurosci. 2007;32:394-99.

37. Schubert CC, et al. Milk based phosphorus increase morning corsitol and improve memory in chronically stressed men. Nutr Res. 2011;31:413-420.

38. Blass EM and Hoffmeyer LB. Sucrose as an analgesic for newborn infant. Pediatrics. 1991;87:215-218.

39. Benton D, et al. Impact of consuming milk drink containing a probiotic on mood and cognition. European J Clinical Nutrition. 2007;61:355-361.

40. Ray L. How ice cream affects your mood. Livestrong. 2011.

41. Smith. Effects of caffeine on human behaviour. Food Chem Toxicolog. 2002;40:1243-1255.

42. Roehrs T and Roth T. Caffeine: Sleep and daytime sleepiness. Sleep Med Rev. 2008;12:153-62.

43. Nobre AC, et al. L-theanine, a natural constituent in tea, and its effect on mental state. Asia Pac J Clin Nutr. 2008;17:167-168.

44. Rao TP, et al. In search of a safe natural sleep aid. J American College Nutr. 2015;34:436-447.

45. http://www.foodnavigator.com/