Healthier Snacking for Corporate Adults: Impact on Cognitive health, Energy levels and hunger satisfaction

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The availability, taste and low price of junk food has led to worldwide increase in their consumption. A growing trend of snacking in between meals for satisfaction of hunger is being observed amongst corporate employees. Research indicates that craving for junk food retards brain motivation and reward pathways. At present, vast fraction of population is suffering from critical health issues (Obesity, cardiovascular diseases and diabetes) because of unhealthy snacking and low protein intake. In this study a protein rich snack was developed that satisfies hunger and at the same time benefits our health. A survey was conducted to know the improvement in protein content of subjects and also how it affected their cognitive health.

Keywords: Junk food, obesity, corporate adults, cognitive health, snacking.

INTRODUCTION

The modern era is observing a rise in rates of life style diseases as more and more people adopt the western diet because of its convenience. The prevalence of cancer, cardiovascular diseases and diabetes is rapidly increasing equally among young adults and aged individuals (Buse et al., 2007; Klein, et al 2004). Medical experts are advocating dietary intervention as the best existing method to prevent and regulate the aforementioned chronic illnesses (Alberti, et al., 2007). Dietary intervention can be defined as any planned modification in an individual's diet, usually aimed to enhance their overall health (Austin, et al., 1981).

Different researchers have defined snacking from various perspectives (with respect to social interactions, time of consumption and caloric consumption). Generally, it is described as the act of eating small portions in between usual meal times (Piernas, et al., 2010). Snacking is often viewed as a poor choice of diet that is detrimental to our health. But the works of various scientists reveal that snackers are neither nutritionally deprived nor high on calories (Drummond et al., 1995). Junk foods are highly processed products rich in calorie, fat and sugar. They may include sweet products like cakes, ice creams and also savoury ones like chips and burgers. The absence of micronutrients and fibre enhances the breakdown of sugar which gives you a temporary feeling of high energy. This energy soon gets dissipated and leads to tiredness and loss of concentration (Ashakiran, et al., 2012). People get addicted to junk foods because the combination of high sugar and high fat content generates a dopamine mediated feeling of pleasure. Frequent snacking on energy-dense snacks may lead to dental cavities and diabetes mellitus in the long run (Nisar et al., 2009). High salt and cholesterol content of these snacks can trigger major lifestyle diseases, such as high blood pressure, stroke and other heart diseases. A high percentage of these nutrients can also cause gastritis and adversely affect kidney functioning.

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Drowsiness and lack of concentration may occur when high fat containing snacks are consumed over a considerable period of time. The colours and flavours added to junk foods to make them appealing are often carcinogenic and initiate allergic reactions such as asthma and rashes (Ashakiran, et al., 2012). Healthy snacking on the other hand involves nutritious foods rich in antioxidants and dietary fiber that boosts your health and furnishes all the essential nutrients (Diabetes Australia., 2016). In one study, researchers assessed the effect of unhealthy snacks (chocolates, crisps) and healthy snacks (fruits) on the emotional well-being of individuals. The results depicted that consumption of chocolates lead to over eating and depression while consumption of fruits reduced depression, emotional distress and anxiety (Smith, et al., 2014).

Along with unhealthy snacking, most people are also consuming a protein deficient diet (McNeil, et al., 2008). Consuming fewer quantities of protein rich foods or consuming low quality proteins leads to low protein intake. Low quality proteins do not provide the essential amino acids that our body is unable to synthesize. Consequently, our body starts breaking down protein rich tissues like muscles to obtain these essential amino acids. Thus, a low protein intake will cause fatigue, muscle degeneration and a weakened immune system due to lack of sufficient antibodies (Rasaily, et al., 2012; Thalacker-Mercer., et al., 2007).

Selection of high quality proteins that contain all the essential amino acids in adequate proportions required by our body is essential for our health (Millward D.J., et al., 2008). Generally animal sources of protein are considered as high quality proteins as they contain all the essential amino acids (Neumann, et al., 2002). Plant proteins are deficient in one or more essential amino acids. But when two or more plant proteins are combined together they too can form a high quality protein product. Good quality proteins are responsible for maintaining bone and muscle health. They also help in lowering the risk of cardiovascular diseases and type 2 diabetes (McNeil, et al., 2008).

Several researchers have investigated the benefits of healthy snacking and protein rich diet on cognitive health and hunger satisfaction in people belonging to various age groups. Most of these studies have targeted adolescents and teenagers. None of the studies have focused on corporate employees among whom lifestyle diseases are an emerging trend. A survey conducted by ASSOCHAM (The Associated Chambers of Commerce and Industry of India) indicated that 72% of corporate employees are suffering from cardiovascular diseases due to excessive stress, tedious schedules, poor diet and lack of exercise. It further revealed that the risk of getting a heart attack was more in case of night shifters who have a higher tendency to consume junk foods. 55% of the respondents belong to the 20-29 years age group and majority of the participants belonged to IT/BPO sectors (ASSOCHAM report, 2002). There is a growing need to identify the effects of snacking and protein deficiency on health of corporate adults and establish suitable dietary intervention for their well-being.

The primary phase of this research work was designed on the basis of pre-clinical studies to observe the changes in an individual’s health on consumption of snack made from good quality protein. The increase in blood serum protein upon daily consumption of this snack was noted. The impact of the snack on the cognitive health, temperament and hunger satisfaction of subjects was also studied. The second phase of this research was carried out to establish that the protein rich snack was better from a nutritional point of view. Some popular snacks consumed by corporate employees were selected through a survey and the protein content of all was chemically estimated and compared with the protein rich snack.

**MATERIALS AND METHODS**

**Development of Test Product**

As is evident from above the principal objective of this work was to develop a healthy snack that helped to improve overall health and wellbeing of corporate adults. The secondary objective of this study was to revive traditional Indian food ingredients that are getting extinct with the progress of urbanisation. Traditional Indian foods are often characterized as functional foods as they are composed of probiotics, dietary fibers, antioxidants etc. These indigenous ingredients improve immune systems, help in weight management and regulating our blood sugar levels (Sarkar, et al., 2015). Keeping the aforementioned objectives in mind, a protein enriched snack was developed in laboratory scale. It is composed of rice flakes and assorted nuts roasted with spices. Each ingredient has been selected keeping in mind their beneficial effect on health and nutrition of individual. The proximate composition shows that it provides 20% of the Recommended Daily Intake of protein for Indians of adults and children above 4 years of age (RDA 2010 Draft document). The product is trans-fat and cholesterol free. Also it is a good source of dietary fibre and calcium.

**Study Design**

Parallel arm design for pre-clinical studies was adopted in the first part of research. In this study design, volunteers participate only in a single dietary intervention. This design provides swift results and does not require long term trials (Abumweis, et al., 2010). The subjects of the study were divided into two groups i.e. test and reference respectively. The volunteers in test group consumed the snack daily for the duration of clinical studies and those in reference group did not consume it at all. The diet format for the study duration was chosen as free-living. In free-living background diet subjects have...
Table 1. Eligibility criteria for the survey

<table>
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<th>Inclusion criteria</th>
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<tr>
<td>• Aged 20yrs – 35yrs</td>
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<td>• Corporate employees</td>
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<tr>
<td>• Non-smoker</td>
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<tr>
<td>• Suitable cognitive skills with respect to age</td>
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<td>• Competent in written and spoken English</td>
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<table>
<thead>
<tr>
<th>Exclusion criteria</th>
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<tr>
<td>• High blood pressure</td>
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<tr>
<td>• Body weight ≤ 90 kg</td>
</tr>
<tr>
<td>• Cardiovascular, kidney, gastrointestinal and liver diseases</td>
</tr>
<tr>
<td>• Taking medication</td>
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<td>• Head or brain injury in past</td>
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Figure 1. Average total protein content of test and reference subjects on 0 day and 15th day of clinical studies.

the freedom to self-select diets while consuming the food product of concern. This format of background diet is generally applied to study the effectiveness of a product or treatment (Abumweis, et al., 2010; Health Canada., et al., 2009). The subjects were provided with a daily diet calendar to fill in the details of their three meals per day and also if they consumed any additional food. The volunteers for this study were healthy young adults, who are corporate employees. The participants were subjected to a screening process for selection. The screening involved a general examination (body mass, height and blood pressure). The volunteers also filled a simple questionnaire related to any health issues or medications they are having. Study was conducted for duration of 15 days with four members in the test group and four in the reference group. The eligibility criteria for this study are given in Table 1.

Test Food

Test group volunteers were given two servings of the snack (35 g each) at morning and evening daily for 15 days. They were provided with a diet calendar to fill in the details of their meals for the duration of trial. The volunteers belonging to reference group were not subjected to any dietary interventions.

Blood Test & Cognitive Assessment

All volunteers were tested for protein content in blood and improvement in cognitive health. The comparative study of the initial and final results of the blood test, mood scale and cognitive battery tests served as end point measurements of the clinical trial. The blood tests: total protein, serum albumin and serum globulin, were conducted in association with a diagnostic center. The cognitive battery tests carried out were: Visual Verbal Learning Test (VVLT) and grooved peg board with slight alterations (Rey., et al., 1964; Wang., et al., 2011). A brief mood introspection scale was daily monitored as well (Mayer, et al., 1988).

Comparison of Protein content

A questionnaire was circulated among corporate employees to know their snacking habits and preferences. Based on the survey results the most popular snacks were selected and their nutrition profile compared with the protein rich snack developed. The protein content of the selected snacks as well as the protein rich snack was chemically analysed in the laboratory. Internationally accepted standard procedure for protein content as described in AOAC 20th edition (2016) has been followed.

RESULTS

Total Protein

Blood tests were conducted before beginning the trials and again after completion of the trial duration to observe the changes in the protein content after consumption of the snack. Figure 1 shows a considerable increase in the
total protein content of all test subjects from the 1st day to the 15th day of consuming the snack. A slight increase in protein content is observed in the reference subjects as well.

**Serum Albumen Content**

Only a slight decrease in the serum albumen of test subjects was observed in comparing the data of initial and final days given in Figure 2. Similar trend was shown by the reference subjects but the reduction was more pronounced in this case.

**Serum Globulin Content**

The Serum Globulin content in blood of test and reference subjects was measured on 0 day and 15th day of the clinical trials and the results are depicted in Figure 3. The test subjects showed an increase from initial to final day. A slight increase in serum globulin of reference subjects was also noted.

**Visual Verbal Learning Test**

Visual Verbal Learning Test (VVLT) was conducted to check the improvement in memory upon daily consumption of the snack. An appreciable improvement is observed in the memory of test subjects from the initial day. No significant change is observed in the reference subjects. These observations are depicted in Figure 4.

**Reflex Activity Test**

The improvement in reflex action of test subjects was
Figure 5. Average results of reflex activity test performed by test and reference subjects on 0 day, 7th day and 15th day of clinical studies.

Figure 6. Individual score of the 4 test subjects for the mood introspection scale of test subjects on 0 day, 7th day and 15th day of clinical studies.

measured by conducting a modified version of the grooved peg test. As can be seen from Figure 5, marked improvement in reflex activity is observed in test subjects while the level of reflex activity is almost constant for reference subjects.

Mood Introspection Scale

Based on a brief mood introspection scale developed by John D Mayer, the test subjects were provided with a daily mood calendar. An overall improvement in their mood was observed at the end of the trials. The compiled data for daily mood analysis of test subjects is given in Figure 6.

Comparison of protein content

The survey results indicate fried snacks are preferred by majority. Potato Chips and traditional snacks like Banana Chips, Mixtures and Pakkavada turned out to be the most popular fried snacks consumed on a daily basis.

Note: Banana Chips, Pakkavada and Mixture are traditional Indian Snacks

The graphical representation of the trend of protein content in the snacks is illustrated in Figure 7.

DISCUSSION

The blood test, total serum protein is conducted to measure the total protein content in an individual’s blood. It is a biochemical test that gives an estimate of the total of all fractions (albumin and globulin). The optimum range for total proteins in adults is 6.0 g/dL to 8.0 g/dL (Busher et al., 1990). An appreciable increase in total protein (7.5 %) is observed on comparing the results of initial day and 15th day.

Consumption of the protein rich snack daily for 15 days enhanced the serum protein content of test subjects. The reference subjects who were not given the snack also showed a slight increase in protein content (3.97 %) after 15 days. This may be because of protein deficient diet as no restrictions were laid down for them during the study period. Since the snack developed contains good quality proteins its contribution to total serum protein was more.

Serum albumin protein serves as a carrier for lipids, steroids and hormones and maintains the osmotic...
Figure 7. The protein content of different snacks under study.

Table II. Nutrition Profile of protein rich snack.

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<th>NUTRITION FACTS/100g</th>
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<tr>
<td>Energy value 491.3 Kcal</td>
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<tr>
<td>Total fat 24.9 g</td>
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<tr>
<td>Saturated fat 10.7 g</td>
</tr>
<tr>
<td>Monounsaturated fat 13.0 g</td>
</tr>
<tr>
<td>Polyunsaturated fat 1.2 g</td>
</tr>
<tr>
<td>Trans fat 0 g</td>
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<tr>
<td>Cholesterol 0 mg</td>
</tr>
<tr>
<td>Sodium 621.7 mg</td>
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<tr>
<td>Total carbohydrate 52.2g</td>
</tr>
<tr>
<td>Dietary Fibre 5.1 g</td>
</tr>
<tr>
<td>Sugar 8.7 g</td>
</tr>
<tr>
<td>Protein 14.6 g</td>
</tr>
<tr>
<td>Calcium 168.8 mg</td>
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<tr>
<td>Iron 3.7 mg</td>
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pressure between tissues and blood vessels. The range for serum albumin in blood is 3.5g/dL to 5 g/dL (Busher et al., 1990). The serum albumin content in test subjects seems to have reduced minutely (1.7%). The probable reason could be that the protein rich snack is composed of proteins of plant origin which do not contribute as much as animal protein towards serum albumen. Previous studies denote that albumin synthesis exhibits high sensitivity to slight fluctuations in amino acid availability. Lower digestibility and amino acid score of plant proteins leads to reduction in serum albumin synthesis (Caso, et al., 1999). The reference subjects also showed a decline in their serum albumin content (3.46 %). Again since the diet of reference subjects was not specified or regulated, this may have led to a decrease in their serum albumin content. The decrease is more in case of reference subjects may be due to consumption of low quality protein diet.

Serum globulin is fractions of soluble protein that basically functions as antibody and helps in maintaining a healthy immune system. The range for serum globulin in blood is 2.0 g/dL to 3.5 g/dL (Fulks et al., 2014). A substantial increase in serum globulin content (21.1%) is noted. This increase is probably due to an overall increase in total protein content from initial to final day of survey. The reference subjects show a 14% increase in serum globulin content as well.

The Visual Verbal Learning Test (VVLT) is a cognitive battery test conducted to assess the immediate and delayed memory and interference effects (Rey et al., 1964). A slight modified version of the test was conducted in the survey. 16 words appear in a random sequence at the rate of 1 word per 2 seconds on the screen. The test and reference subjects have to recall the words and write them down within 1 minute. The average result of test subjects reveal that the recollection power improved from 12.25 words per minute to 17 words per minute. The essential amino acid composition of snack enhanced the cognitive health of test subjects. The average test results of the reference subjects showed no modification constant throughout the study duration.

Grooved pegboard is another cognitive battery test used to assess the manual dexterity and fine motor skills (Wang et al., 2011). This test was also slightly altered for the survey. A peg board filled with white pegs arranged in an intricate pattern is placed in front of the test or
reference subject. They need to replace the white pegs with red pegs in the same pattern. The time taken to carry out the test is recorded. The reflex activity of test subjects improved considerably during the study duration. The average results depict a decrease from 143 seconds to 104 seconds. While the average results for reference subjects remained almost constant during the entire study period.

In order to monitor the emotional state and mood of test subjects a daily mood calendar was provided. The calendar is based on the brief mood introspection scale developed by J.D. Mayer. In this case the calendar had only eight mood adjectives (Active, Confident, Happy, Satisfied, Nervous, Tired, Sad and Discomfort). The compiled data showed the test subjects felt happier, active and satisfied over the study period. The overall improvement in mood can be due to consumption of protein rich snack. Previous studies indicate that consumption of dietary protein having all essential amino acids increases the secretion of dopamine and its metabolite homovanillic acid which induces feelings of happiness and well-being (Hoertel et al., 2014, Fernstorm et al., 2007).

The comparison of protein content of snacks revealed the protein rich snack contained 14.6% of protein that was higher than all the other snacks analysed. Researchers have concluded from earlier studies that consumption of high protein food leads to reduction in appetite without any change in energy intake (Veldhorst et al., 2009). The protein rich snack is also high in calcium, iron and unsaturated fat. The combination of all these nutrients is responsible for enhancing the overall health and wellbeing of individuals. The complete nutrition profile of the snack developed is given in Table II.

**CONCLUSION**

The present work was intended to study the effect of a protein rich snack as a healthy alternative on cognitive power, hunger satisfaction and mood of corporate employees. It can be concluded from the above observations that the snack developed contributes to the dietary protein intake of individuals. Considerable enhancement in cognition and reflex action of test subjects was observed as well. The daily mood analysis exhibited the test subjects to be more active, happy and satisfied after consumption of the snack. The comparative studies indicate the protein rich snack has higher protein content than snacks consumed daily by corporate employees. Thus, the protein rich snack can be a healthier substitute that enhances both the mental and physical health of corporate adults.

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