UNIVERSITY GRANTS COMMISSION
BAHADURSHAH ZAFAR MARG
NEW DELHI – 110 002

THE FINAL REPORT OF THE WORK DONE ON THE PROJECT

1. **Title of the Project:** Development of electromyographic methodologies to study texture of Indian foods.

2. **NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR:**
   Navdeep Singh Sodhi, Professor, Department of Food Science and Technology, Guru Nanak Dev University, Amritsar – 143 005, Punjab.

3. **NAME AND ADDRESS OF THE INSTITUTION:** Guru Nanak Dev University, Amritsar – 143 005, Punjab.

4. **UGC APPROVAL LETTER NO. AND DATE:** F.No.43-378/2014(SR) dated 10th September, 2015

5. **DATE OF IMPLEMENTATION:** 01-07-2015

6. **TENURE OF THE PROJECT:** Three years

7. **TOTAL GRANT ALLOCATED:** Rs. 16,60,800/-

8. **TOTAL GRANT RECEIVED:** Rs. 16,38,000/-

9. **FINAL EXPENDITURE:** Rs. 16,30,327/-

10. **TITLE OF THE PROJECT:** Development of electromyographic methodologies to study texture of Indian foods.

11. **OBJECTIVES OF THE PROJECT:**

    a. To conduct instrumental texture evaluation using texture profile analysis of various Indian food products.

    b. To develop experimental setup for acquiring data using EMG technique.

    c. To analyze the acquired EMG data using various methodologies.

    d. To compare the instrumental texture parameters with EMG acquired variables.

    e. To standardize the EMG methodology for texture evaluation of various Indian food products.

12. **WHETHER OBJECTIVES WERE ACHIEVED:**

    Yes, all the objectives of the study were successfully achieved. The details of the same are given in the "Summary of the findings" section.

13. **ACHIEVEMENTS FROM THE PROJECT:**

    The outcomes of the project resulted in publication of four research papers, three poster presentations and five M.Sc. theses.

Research Publications

1. Rustagi, S., **Sodhi, N.S.,** and Dhillon, B. (2018). A study to investigate reproducibility of chewing behaviour of human subjects within session recordings for different textured Indian foods using electromyography. *The Pharma Innovation Journal,* 7(5): 5-9.

2. Rustagi, S., **Sodhi, N.S.,** and Dhillon, B. (2018). Analysis of masseter muscle activities acquired by surface electromyography for different textured Indian food products. *International Archive of Applied Sciences and Technology,* 9(2): 51-57*.*

3. Pratiksha, **Sodhi, N.S.,** Dhillon, B., and Kaur, T. (2018). Association between electromyography (EMG) variables during mastication by human subjects and food texture perceptions: a study on different snacks (*gajaks,* biscuits and chocolates). *International Archive of Applied Sciences and Technology,* 9(1): 33-42*.*

4. **Sodhi, N.S.,** Singh, B., Dhillon, B., and Kaur, T. (2019). Application of electromyography (EMG) in food texture evaluation of different Indian sweets. *Asian Journal of Dairy and Food Research,* 38(1): 41-48*.*

Poster Presentations

1. Rustagi, S., **Sodhi, N.S.**, Dhillon, B., and Kaur, T. Poster presentation entitled *"Electromyographic analysis of chewing behaviour of human subjects during mastication of different textured foods".* ESTFP-2018: Emerging and Sustainable Technologies in Food Processing, SLIET, Longowal, Punjab, March 15-16, 2018.

2. Rustagi, S., and **Sodhi, N.S.**, Dhillon, B., Kaur, T. Poster presentation entitled *"To study the reproducibility of masseter muscle activities as observed by electromyography during chewing of foods".* 20th Punjab Science Congress, IET Bhaddal Technical Campus, Ropar, Punjab, February 7-9, 2017.

3. Jaiswal, S., Kumar, A., Dhillon, B., and **Sodhi, N.S.** *"Electromyographic studies on mastication of cookies formulated with brown rice flour".* 8th International Food Convention (IFCoN), CSIR-CFTRI, Mysore, Karnataka, December 12-15, 2018.

M.Sc. Theses

1. Pratiksha. (2017). Application of electromyography (EMG) for texture evaluation of different textured snacks (gajak, biscuit and chocolate). M.Sc. Thesis, Guru Nanak Dev University, Amritsar.

2. Singh, B. (2017). Application of electromyography (EMG) for texture evaluation of different Indian sweets. M.Sc. Thesis, Guru Nanak Dev University, Amritsar.

3. Singh, G. (2017). Application of electromyography (EMG) for texture evaluation of different Indian snacks. M.Sc. Thesis, Guru Nanak Dev University, Amritsar.

4. Pant, K. (2018). Application of electromyography (EMG) for texture evaluation of different Indian fried snacks. M.Sc. Thesis, Guru Nanak Dev University, Amritsar.

5. Suri, S. (2018). Application of electromyography (EMG) for texture evaluation of different fruit preserves. M.Sc. Thesis, Guru Nanak Dev University, Amritsar.

14. SUMMARY OF THE FINDINGS:

In the present study, electromyography (EMG) investigations have been conducted to develop standard methodologies to study texture of Indian foods including sweets, snacks, confectionary, etc. The experimental setup for acquiring data by EMG technique was established in the Department of Food Science and Technology, Guru Nanak Dev University, Amritsar. EMG studies were conducted on healthy subjects who were free from any functional mastication problems and required no dental treatments. Activities of both sides of masseter muscles, the jaw-closing muscles, were measured using EMG, while the subjects ate one mouthful of food sample. Various groups of food products were evaluated in the present study (Group 1: Jelly, cake, *dhokla, rasgulla, paneer;* Group 2: *rasgulla, petha,* milk cake, *gulab jamun, cham cham, channa murgi,* chocolate *barfi;* Group 3: *gajaks,* biscuits, chocolates; Group 4: *paneer pakora, aloo pakora,* vegetable cutlet, cheese cutlet, *kachori, samosa;* Group 5: apple, *bael,* cherry, carrot, gooseberry; Group 6: bread *pakora, paneer pakora, mathi, namakpare, bhakar badi, murmura, kaju matri*). Texture evaluation was also conducted using instrumental texture analyser and sensory analysis.

The acquired absolute EMG variables for entire mastication process, early stage chewing process, middle stage chewing process, late stage chewing process and variables per chew were subjected to two way analysis of variance which indicated more variation in subjects than the food samples. Thus, the relative values of mastication parameters of each subject were served for statistical analysis rather than using their absolute values. The results indicated that the relative EMG mastication parameters eliminate subject variance and can effectively distinguish different textured Indian foods.

The reproducibility of masseter muscle activities during chewing of different textured foods as observed by EMG for two different recordings in a session by a human subject was also examined. Correlation coefficients were found to be statistically significant ($p < 0.05$) for two different recordings of various foods. The

dendrograms generated by cluster analysis indicated that the same subject's recordings were clustered more closely. Thus it is concluded from the study that chewing behaviour is reproducible within a session for human subjects and can be used for investigating textural differences among various foodstuffs.

A few variables were selected from the acquired EMG variables by cluster analysis. Further principal component analysis (PCA) was carried out on the selected variables to obtain smaller number of independent variables which could explain the variability in mastication behaviour of human subjects for different groups of food samples investigated in the study. For each food group studied, a different set of independent variables were obtained which could explain foods' textural characteristics based on their correlations with instrumental textural parameters and sensory perceptions.

To conclude, standard EMG methodologies have been developed which could explain the texture of various Indian foods. The study will help in filling the gap between sensory evaluation and instrumental textural analysis which could further assist in better understanding of the textural behaviour of the products being developed by Indian food industry.

15. CONTRIBUTION TO THE SOCIETY:

Although electromyography (EMG) is commonly used in physiotherapy and psychology for evaluating human health and in diagnosis of diseases related with human neuro muscular system. However, in India its application in the field of food science has not been explored so far. The present study is a pioneer research investigation in applying EMG in the area of food science in India. This is a promising technique to analyze mastication and swallowing behaviours of human subjects for in-mouth food texture evaluation. It offers valuable information regarding final food texture acceptability, which may subsequently help in improving quality of finished products. In the present study, EMG investigations have been conducted to develop standard methodologies to study texture of Indian foods including sweets, snacks, confectionary, etc. The findings of this research will help in filling the gap between sensory evaluation and instrumental textural analysis for the products developed by Indian food industry. Further, this research has opened new avenues for applying the EMG technique to study texture during design and development of new food products for various target groups found in the society who are suffering from abnormal chewing and

swallowing behaviours due to ailments like dysphasia, dental caries, gum problems, etc.

16. WHETHER ANY Ph.D. ENROLLED/PRODUCED OUT OF THE PROJECT:

Registered following **two** Ph.D. students: 1. Mr. Sarvesh Rustagi,
2. Ms. Tanbeer Kaur

17. NO. OF PUBLICATIONS OUT OF THE PROJECT:

The outcomes of the project resulted in publication of four research papers, three poster presentations and five M.Sc. theses.

Research Publications

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(PRINCIPAL INVESTIGATOR)   **(REGISTRAR)**
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