



Effect of Millet Based Cookies Incorporated with Muskmelon Seeds and Jaggery on the Work Performance of Adolescent Girls

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Abstract—Adolescence is the period of time where growth of an adolescent is at optimum level. During this phase of life span the diet plays an important role in their growth and development. Adolescent girls need more nutrients to meet their nutritional requirements. The healthy diet does not only affect adolescent's physical and mental growth but also enhance their performances at sport activities and study. Millets now-a-days are in high demand on the aspect of their high nutritional value. Therefore, the main objectives of this study was to fulfilling the nutritional needs of adolescent girls to enhance their overall work performances. With the introduction of nutritious and healthy cookies which is made up of millets and other nutritive ingredients that helps in alleviating the problems of nutritional deficiencies. Three types of cookies were formulated incorporating composite flour of pearl millet, natural sweetener (jaggery) and agro-waste seed (muskmelon seeds). Seeds were used at different level, each in three variants (5,10,15%). There were variant A, B and C along with the standard. Composition of millet flour, seeds in all variants were different. Standard cookies were made up of wheat flour and sugar. Three groups were formed along with control group. Group A, B and C were supplemented by the variant A, B and C respectively. Control group was supplemented by standard cookies. Cookies were supplemented for 60 days. Group A showed significant results in comparison to other groups. Results concluded that variant A of millet based cookies are more nutritious and helps in improving work performance of adolescent girls.

Keywords- Nutritional requirements, work performance, variants, composite flour, standard cookies.

I. INTRODUCTION

An important indicator for national development is the health status of the community. The agricultural products which are nutritionally rich but underutilized and ignored by us must be introduced to the people. Promotion for the utilization of nutritionally rich discarded seeds and little familiar millets will be one of the best paths towards the achieving good human health and stable nutritional status specifically in adolescent school girls. Adolescence is a period of time where nutritional needs of the body get increases due to changes in body composition, increase in growth rate. In the developing country like India, adolescent girls are more prone to suffer from Iron Deficiency Anemia or other nutritional deficiencies because of various factors such as common customs, social beliefs against females, menarche etc. Maintenance of health and providing adequate nutrition is crucial in adolescent girls as they are tomorrow's adult population (Shekhawat *et al*, 2014). Value additions are an accessible, practical and straight forward approach to increase the nutritional value of any food product and are useful for our health by meeting the nutritional requirements. For value addition, seeds of fruits or vegetables which pose high nutritional value are being used in many food industries. Seeds may be tiny but each one is packed with all nutrition. The term agro-waste seeds refer to nutrient-dense edible seeds which are discarded. These agro-waste seeds can be used instead of throwing them because they contain nutrients along with phytochemicals. Making valuable addition to different food products, natural and organic ingredients are used which enhance the nutritive value such as natural sweeteners. An ancient natural sweetener, Jaggery rich in phytochemicals is obtained by the process of evaporation of sugarcane juice (Nayaka *et al*, 2014). In India the demand by consumers for composite flour based bakery products like cookies, biscuits, pastries, muffins etc. is increasing. Cookies is one of the most popular baked food that can be consumed by people of each age group and are becoming more and more popular because they are readily available, convenient to consume, and have a relatively long shelf life. It is consumed widely and have importance throughout the world so it can be a feasible way to use composite flour to make it more nutritious (Bala, 2015). Cookies are well-liked by consumers in India due to their ease of use, portability, accessibility at reasonable rates, and long shelf life under normal conditions. Many findings have shown that having a nutritionally balanced and healthy diet improves brain capacity, maximizes cognitive development or overall performance (Rausch, 2013). This study involved the analysis of work performance by the adolescent girls after supplementation of the prepared value added nutraceutical pearl millet based cookies. The effect of the cookies have been observed on their overall health by evaluating their work performance by using different methods.

II. REVIEW OF LITERATURE

Millets are the principal food source in the world's arid and semi-arid regions. Millets are good sources of energy. They provide fibre, polyphenols, minerals, vitamins, fatty acids, protein, and other nutrients. The typical millet protein contains a high quantity of essential amino acids, particularly sulfur-containing amino acids methionine and cysteine. The nutritional potential of millets needs research into the nutritional and practical characteristics of diverse millet cultivars, as well as the development of value-added millet products (Chauhan et al., 2018; Amadou et al., 2013). Nowadays people are more concerned about high quality food items which are available at a reasonable rate also. Food manufacturing units are continuously putting their efforts in developing such food products which use high nutritious ingredients like millets. According to the Ministry of agriculture and welfare, The United Nation's General Assembly has declared 2023 as an International Year of Millets (Mathew et al, 2022).

Pearl Millets:

| Taxonomical classification | |
|----------------------------|------------------------------|
| Kingdom | <i>Plantae</i> |
| Family | <i>Poaceae</i> |
| Species | <i>P. glaucum</i> |
| Order | <i>Cucurbitales</i> |
| Genus | <i>Pennisetum</i> |
| Botanical Name | <i>Pennisetum glaucum</i> L. |
| Local name | <i>Bajra</i> |

Source: Satyagopal et al., 2014

Pearl millet is well adapted to production systems with little rainfall (200-600 mm), low soil fertility, and high temperatures, it can be grown in areas where other cereal crops, such as wheat or maize, would not survive. Pearl millet is a staple food for households in the poorest countries and among the poorest people in its traditional growing regions (Chauhan and Sarita, 2018). This crop is high in phosphorus, potassium, copper, manganese, zinc, iron, and magnesium. It is a good source of energy, with a calorific value of 361 Kcal/100g and high fibre content 1.2g/100g. Pearl millet has higher protein content and is high in vitamin B, vitamin A, folic acid, calcium, and magnesium, according to Pattanashetti et al., (2016). Pearl millet provides various health advantages because of its high mineral and protein content.

Byproducts from the industrial processing of fruits and vegetables include bran, stem, fibrous debris, peel, and seeds. Despite being a rich source of numerous nutrients, such as vitamins, minerals, amino acids, and fatty acids, as well as biologically active substances, such as phytochemicals, the majority of these by-products are eliminated. Furthermore, the fruit seeds are high in oils, which are inherently high in bioactive chemicals and antioxidants.

Muskmelon Seeds

| Taxonomical classification | |
|----------------------------|---------------------------|
| Kingdom | <i>Plantae</i> |
| Family | <i>Cucurbitaceae</i> |
| Species | <i>C. melo</i> |
| Order | <i>Cucurbitales</i> |
| Genus | <i>Cucumis</i> |
| Botanical Name | <i>Cucumis melo</i> L. |
| Local name | <i>Kharbooz, kharbuja</i> |

Source: Mariod et al., 2017

The muskmelon (*Cucumis melo*) family of melon includes varieties with smooth skin, like the Crenshaw, Casaba, and Honeydew, as well as types with netted skin, like the cantaloupe, Santa Claus or Christmas Melon, and Persian melon. Melons like cantaloupe are a great source of vitamins A, C, potassium, and magnesium. Its beneficial medical qualities, including analgesic, anti-inflammatory, antioxidant, anti-ulcer, anti-cancer, anti-microbial, diuretic, anti-diabetic, and anti-fertility action, have been demonstrated (Mehra et al., 2015). The muskmelon seed contain high percentage of lipid 30.6% and protein 14.9%, crude fiber 23.3%, ash 2.4% carbohydrate 19.8%. The protein in muskmelon seeds looks to be edible, and adding specific amino acids improves the protein's nutritional value. The content

of fatty acids varied from negligible levels to nearly 64%. The limiting amino acids in seed proteins were methionine and lysine, while arginine, aspartic acid, and glutamic acids were abundant (Manchali & Murthy, 2020).

Only naturally occurring sugars and carbohydrates found in live plants such as vegetables, trees, seeds, nuts, and roots are healthy to consume, along with wild, non-hybridized, seeded fruits. Jaggery, maple syrup, honey, stevia, molasses, coconut sugar, date sugar, agave nectar and xylitol are examples of natural sweeteners.

Jaggery

Sugarcane is the principal source of sweeteners in India. Jaggery manufacture is one of India's oldest and most important cottage industries. Jaggery is utilised in a range of sweet food dishes as well as as a sweetening agent because it is affordable and widely available. One of them is jaggery (noncentrifugal sugar), which is manufactured from sugarcane juice. It has been known to mankind for about 3000 years and is an important part of many countries' rural diets. Jaggery, which is produced in addition to sugar from sugarcane juice, is a popular item, particularly among the impoverished in rural regions (Singh et al., 2018).

Jaggery is considered a nutraceutical due to its high concentration of vital amino acids, antioxidants, phenolics, minerals such as calcium, phosphorus, iron, and vitamins. Jaggery is a better natural source of nutrients and could be utilised as a healthier nutritional option for white sugar. The nutraceutical value of jaggery can be increased through value addition and fortification with medicinally significant herbs and spices. Jaggery is found to be good in treating digestive disorder, anemia, cancer, jaundice and stress (Nath et al., 2015)

III. METHODS AND MATERIALS

3.1 Collection of raw materials

Pearl millet was purchased from local market of Jaipur. Muskmelon seed was purchased online. Sweeteners jaggery was arranged from Ayodhya, Uttar Pradesh.

3.2 Preparation of composite flour

Pearl millets were first roasted then grinded into fine particles. Seeds were also roasted and then grinded very coarsely. Composite flour was prepared by mixing the grinded millets flour, wheat flour and the seeds.

3.3 Formulation of value added cookies

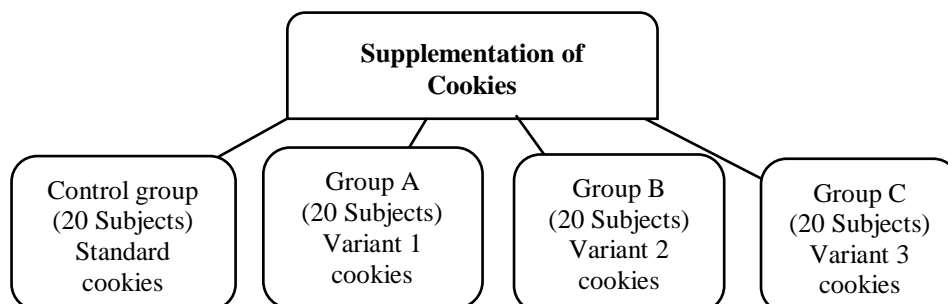
Cookies were formulated by using different raw ingredients in different ratio according to their nutritive variations. In the following table, the compositions of different variants of cookies are given.

Table 3.2: Composition of different variants of cookies

| Cookies | Standard | Variant A | Variant B | Variant C |
|----------------|--------------------------------|---|--|--|
| Jaggery | White flour (80g) + sugar(20g) | Wheat flour (20g) + Pearl millet (45g) + Muskmelon seeds (5g) + Jaggery (30g) | Wheat flour (20g) + Pearl millet (40g) + Muskmelon seeds (10g) + Jaggery (30g) | Wheat flour (20g) + Pearl millet (30g) + Muskmelon seeds (15g) + Jaggery (30g) |

3.4 Supplementation of Prepared Cookies

Selection of Adolescent Girls



Adolescent girls were selected randomly and taken as subject in the study by their consent. Convenience sampling was done in this study. Four groups were formed for the supplementation of different cookies. One group was taken as Control group and other three groups were named as Group A, Group B and Group C. Each group contains 20 adolescent girls as a subject. These girls were selected in the Banasthali premises.

3.5 Pre and Post Assessment The evaluation of physical test before and after the intervention was done by using methods from Chauhan, 2013.

3.5.1 Muscular Endurance Test:

Grip Dynamometer muscular endurance test

Equipment: A hand grip Dynamometer

Procedure:

- Subject is asked to hold the grip dynamometer over head and to squeeze it by lowering the arm steadily downwards to the right side of the body while continuing tightening the grip without letting the hand, arm or elbow touch the body.
- The indicator needle gives the score for the maximum grip squeeze either in kg or pounds.

Scoring: Number of correct repetitions at 2/3 rd level of grip strength gives the score of static repetition muscular endurance measurement.

3.5.2 Cardio-Pulmonary Endurance Test:

Tuttle pulse ratio test:

Equipment: a stopwatch, a tape recorder or metronome, and a stool that is 13 inches high.

Procedure:

- The subject's resting pulse rate is monitored for 1 minute while they are seated.
- Following the measurement of the subject's resting pulse rate, the subject is requested to ascend and descend at a rate of 30 steps per minute on a 13-inch high stool.
- The participant is instructed to sit down once 30 step-ups have been accomplished in one minute.
- The pulse rate is counted immediately and continuously for 2 minutes.

Scoring:

Tuttle Pulse ratio = After exercise 2 minutes pulse count / one minute resting pulse count.

IV. RESULTS AND DISCUSSION

Cookies are the sweetened snack which mainly made up of white flour and sugar. In this study natural sweetener jaggery was incorporated in place of sugar with millets flour. Three variation of millets based cookies were developed and sensory evaluation was conducted by the trained panel.

Table 4.1: Sensory evaluation of all variants of jaggery cookies

| S.No | Attributes | Standard | Variant A | Variant B | Variant C |
|------|-----------------------|----------|-----------------------|-----------------------|----------------------|
| 1. | Color | 8.3±0.6 | 7.0±0.6 ^{NS} | 7.1±0.7 ^{NS} | 7.2±0.8 ^S |
| 2. | Appearance | 7.9±0.7 | 7.4±0.5 ^{NS} | 7.1±0.6 ^{NS} | 7.3±0.9 ^S |
| 3. | Flavor | 7.8±0.9 | 8.1±0.2 ^{NS} | 7.8±0.3 ^{NS} | 7.4±0.4 ^S |
| 4. | Texture | 7.7±0.7 | 8.1±0.4 ^{NS} | 7.3±0.2 ^{NS} | 7.2±0.3 ^S |
| 5. | Taste | 7.8±0.8 | 8.2±0.5 ^{NS} | 7.4±0.4 ^{NS} | 7.5±0.5 ^S |
| 6. | Overall Acceptability | 7.9±0.7 | 8.1±0.7 ^{NS} | 7.2±0.8 ^{NS} | 7.6±0.6 ^S |

(Value = mean ± SD), S: Significant (p<0.05), NS: Non-Significant (p>0.05)

| | |
|--|--|
| Standard: 100% wheat flour | Variant A: 20% wheat flour + 45% composite millet flour + 5% muskmelon seeds + 30% jaggery |
| Variant B: 20% wheat flour + 40% composite millet flour + 10% muskmelon seeds + 30% jaggery | Variant C: 20% wheat flour + 35% composite millet flour + 15% muskmelon seeds + 30% jaggery |

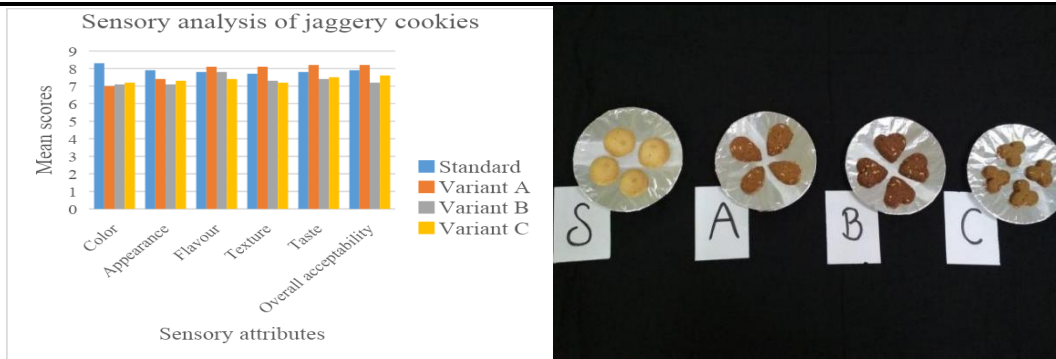
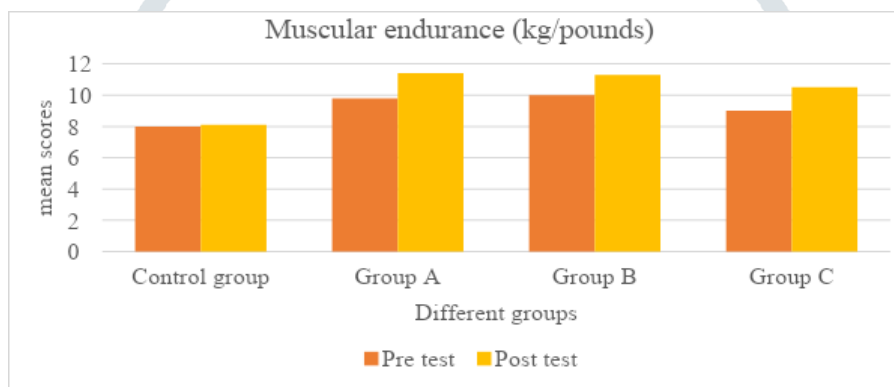


Fig. 4.1 Sensory evaluation of all variation of jaggery cookies

In terms of flavor, texture, taste, variant A was found to be highly acceptable in comparison to standard and other respective variants. Variant C got highest score in terms of color and registered significant difference at $p < 0.05$ level. On other hand variant B was found to be moderately acceptable by the panel members and registered insignificant difference at $p > 0.05$ level when compared to standard and other variants of jaggery cookies. Variant A has got highest scores and showed insignificant difference as compared to standard.

4.2 Muscular endurance test (Grip dynamometer test)

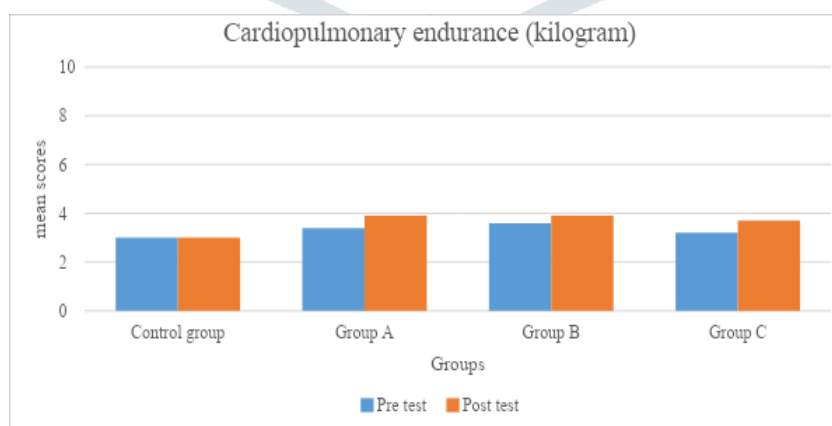
Figure 4.2 revealed that muscular endurance of adolescent girls has been improved significantly. Grip strength of adolescent girls were found to be increased after supplementation.



4.2 Analysis of muscular endurance of all the groups

4.3 Cardio-pulmonary endurance test (Tuttle pulse ratio test)

Figure 4.3 revealed that the cardiopulmonary endurance has been improved slightly after the supplementation of all the variants of cookies. There was significant difference found in groups at the level of $p < 0.05$ difference. Group A and group C showed similar results in post testing values. Group B showed lower cardiopulmonary endurance than the other groups in post testing results. Control group was found to be significant in comparison to pre and post results after supplementation.



4.3 Analysis of cardiopulmonary endurance test of all the groups

V. CONCLUSION

Millets based cookies were found to be good in improving muscular endurance and cardio-pulmonary endurance of the adolescent girls. Group A was supplemented by variant A of jaggery cookies. Composition of variant A of jaggery cookies was 20% wheat flour, 45% pearl millet, 5% muskmelon seeds and 30% jaggery. Group B was supplemented by the variant B of millet based cookies. Group C was supplemented by variant C of millet based cookies. It has been concluded that muscular endurance and cardio-pulmonary endurance have been improved in group A. This can be improve as the millets provides complex carbohydrates that can be a source of energy and

the butter is a great source of fuel which may help muscles to perform better and potentially enhancing the strength. Muskmelon seeds used in cookies are nutrient-dense, containing essential minerals, healthy fats and protein which can indirectly support the development of muscle strength and muscular endurance. Jaggery contains good amount of iron and iron levels are important for maintaining optimal oxygen-carrying capacity, which is vital for endurance activities.

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