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Assessment of satiety and compliance to high protein diets designed for a weight loss regimen

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Protein in the diet is a strong determinant of satiety. The study was conducted on 61 adult women to determine the role of high protein diet in imparting satiety in a weight reducing regimen of three months period. The high protein (HP) diets were more satiety providing as compared to normal protein (NP) diets with average score ranged between 5-7. A significantly (p = 0.05) higher compliance was observed in high protein and exercise (HP+E). The study concluded that group when compared to HP group for breakfast, mid morning and evening tea while compliance for early morning and dinner was significantly (p = 0.05) higher in HP group. NP group had significantly (p = 0.05) lower compliance for four meals *i.e.* early morning, breakfast, mid morning and post dinner as compared to HP and HP+E group. The study concluded that the satiety scores and compliance of designed high protein diets were higher than the normal protein diet for most of the meals. Therefore, high protein hypocaloric diet is a better approach in weight loss regimen as it imparts more satiety and has better compliance.

Key Words : High protein diets, Satiety, Normal protein diet, Hypocaloric diet, Dietary compliance

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INTRODUCTION

Obesity has become a global concern. It is a condition in which there is an excess of body fat. The causes of overweight and obesity can be linked to behavioral, metabolic, and genetic factors. However, ultimately, weight gain occurs due to positive energy balance, in which energy intake exceeds energy expenditure. Being too fat, especially to the point of obesity, is positively harmful to the health. It is an important public health problem associated with multiple chronic health conditions including heart disease, hypertension, hyperlipidemia, diabetes, hyperinsulinemia, and cancer. The increasing prevalence of overweight and obesity highlights the need for improved intervention strategies to counteract this significant public health problem (Jackicic and Otto, 2006).

Diet, which plays an important role in every individual's life, is always connected with health. Dietary approaches for controlling unhealthy weight gain are becoming increasingly important and using dietary manipulations to control hunger is one potential means to control energy intake (Baer *et al.*, 2011). Diet composition can play a role in obesity treatment because it can influence energy intake and nutrient balance. Diets must control energy intake in order to maintain or reduce body weight (Layman *et al.*, 2003). There are many conventional dietary approaches to weight management, recommended by the leading research and medical societies (Deibert *et al.*, 2004), however body weight management requires a multifactorial approach, because several pathways are involved in the system of body weight regulation (Hochstenbach-Waelen *et al.*, 2009).

Generally, selection of a diet high in fibre, low in energy density and glycemic load, and moderate in protein is thought to be particularly important for weight control (Abete *et al.*, 2010). Such a diet may be achieved by regularly consuming foods from certain food groups, including fruits, vegetables, and whole grains; some lean meats, nuts and legumes; and limited consumption of foods from other groups, including high-fat meats, sugar-sweetened beverages, bakery items, and highly processed foods (McCrory *et al.*, 2010). High-protein

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diets have recently been proposed as a "new" strategy for successful weight loss (Jeor *et al.,* 2001).

Dietary protein is critical to help build and maintain muscle mass because it provides essential amino acids. However, not all proteins are created equal. It is important to include high-quality protein as a part of daily diet because it contains all of the essential amino acids the body needs to build proteins, which helps the body to function properly. Protein generally increases satiety to a greater extent than carbohydrate or fat and may facilitate a reduction in energy consumption under *ad libitum* dietary conditions; higher-protein diets are associated with increased thermogenesis, which also influences satiety and augments energy expenditure (Paddon-Jones *et al.,* 2008). The present study has assessed the satiety and compliance of high protein diets so that they become effectively used as a basic tool in a weight reducing regimen.

METHODOLOGY

The volunteer women faculty and non–faculty members of Punjab Agricultural University, Ludhiana and in the age group of 35-55 years with body mass index (BMI) in the range of 25-35 kg/m^2 were recruited to participate in the study via wide circulation regarding importance of dietary protein and exercise to reduce body weight without losing muscle mass. A total of 61 subjects were enrolled in the study. The subjects were given option to choose one out of three regimens mentioned below according to their preference:

- Group I Normal Protein (NP): 1300-1400 kcal/d, 12-15% protein and CHO/Protein ratio of 3.0-3.5.
- Group II High Protein (HP): 1300-1400 kcal/d, 25-30% protein and CHO/Protein ratio of 1.5-2.0.
- Group III High Protein + Exercise (HP+E): 1300-1400 kcal/d, 25-30% protein and CHO/Protein ratio of 1.5-2.0 + Exercise.

The subjects were asked to follow the regimen for three months.A control group with matched BMI and age with no intervention was also studied parallel to interventional groups.

Normal and high protein hypocaloric diets with specified quantities of culturally accepted foods were designed for selected vegetarian and non-vegetarian subjects. The diets were designed keeping in mind the meal pattern, food habits and preferences of the group as studied by Kaur (2011). The designed diets met the requirements of other essential nutrients as per Recommended Dietary Allowances (ICMR 2010).

The diets were assessed for their satiety scores reported by the subjects belonging to NP and HP diet groups using a questionnaire before the initiation of the experimental trial using hunger/satiety scale of Burgoon (1998).

During the trial, the subjects attended one meeting each week at Nutrition Research Laboratory of Department of Food and Nutrition with the researchers who provided information about diet and exercise, answered questions and reviewed diet/exercise records for regimen compliance. Continuous motivation to the subjects was made during the meetings. The subjects were given food/exercise check off logs to document adherence to the diet and exercise schedule. The logs were evaluated at the end of 4, 8, 12 weeks. The level of difficulty faced by the subjects in three groups during the adoption of designed diets was assessed by using a 6-point scale.

The subjects were guided to follow the designed diets for atleast 5 days a week for achieving desirable results. The exercise schedule in consultation with a professional exercise trainer was designed for the subjects who chose the exercise group. The schedule included 20 min walk atleast 5 days a week with 2 sessions per week of resistance/stretch exercises.

Mean and standard deviation for various parameters were computed. Analysis of variance was employed to assess the significant differences between control, NP, HP and HP + E groups. The paired t-test and analysis of variance was derived using Microsoft excel (2003) statistical analysis tool pack.

OBSERVATIONS AND ASSESSMENT

The satiety scores using Burgoon (1998) hunger/satiety scale for normal and high protein diets have been shown in Table 1. The highest satiety score was for breakfast (6.1)

Table 1. Average satiety scores of various meals of normal protein (NP) and high protein (HP) diets (n = 44)

Meals	NP (n = 14)		HP (n = 30)		t values
	Range	Mean ± SD	Range	Mean ± SD	
Early morning	5 – 6	5.2 ± 0.4	5 – 7	6.0 ± 0.7	6.10*
Breakfast	5 – 7	6.1 ± 0.5	5 – 7	6.1 ± 0.5	0.81
Mid morning	4 – 7	4.8 ± 1.3	5 – 7	5.6 ± 0.6	0.03
Lunch	5 – 6	5.4 ± 0.5	6 – 8	6.6 ± 0.7	6.75*
Evening tea	5 – 6	5.7 ± 0.5	5 – 7	5.5 ± 0.6	0.14
Dinner	5 – 6	5.9 ± 0.4	5 – 7	5.8 ± 0.5	0.50
Post dinner	5 – 6	5.7 ± 0.5	6 – 8	6.6 ± 0.8	4.80*

*and** indicates significance of value at P = 0.05 and 0.01, respectively, NS= Non-significant, Hunger/Satiety scale (Burgoon, 1998): 1 = Famished, starving; 2 = Headache, weak, cranky, low energy; 3 = Want to eat now, stomach growls and feels empty; 4 = Hungry - but could wait to eat, starting to feel empty but not there yet; 5 = Not hungry, not full; 6 = Feeling satisfied, stomach feels full and comfortable; 7 = Feeling full, definitely don't need more food; 8 = Uncomfortably full; 9 = Stuffed, very uncomfortable and 10 = Bursting, painfully full.

followed by dinner (5.9) in case of NP diets, while lunch and dinner (6.6) had the highest satiety score followed by breakfast (6.1) for HP diets. Mid morning (4.8) had the least satiety score in NP diet and in case of HP diet, evening tea (5.5) had the least satiety score. A significantly ($p = 0.01$) higher satiety scores for early morning, lunch and post dinner meals were observed in case of HP diets when compared to NP diets.

The acceptable range of satiety score was between 5 to 7 while satiety score below 4 indicates hunger and more than 8 indicates uncomfortably full (Burgoon, 1998). Table 2 depicts the classification of subjects in NP and HP groups according to their satiety scores. All the subjects in NP group, mentioned satiety scores ranging between 5 to 7 for all meals except mid morning meal. On the other hand, all the subjects in HP group showed satiety scores between 5 to 7 for all the meals. Ten and 20% of subjects felt that lunch and post dinner, respectively were more than needed (satiety score 8 or more). The result concluded that the HP diets were more satiety providing as compared to NP diets with average satiety scores lying between 5 -7.

The protein content of food is a strong determinant of short-term satiety as reported by Anderson and Moore (2004). It was found that the use of a higher-protein diet improves perceptions of satiety and pleasure during energy restriction (Leidy *et al.,* 2007). Leidy *et al.* (2010) also stated that the consumption of high protein intake improved appetite control and satiety in overweight/obese men during energy restriction-induced weight loss.

Table 3 depicts per cent compliance to meals of the designed diets by the subjects in NP, HP and HP+E groups. In case of NP group, the maximum compliance was for lunch (90.3%) followed by breakfast (87.5%) whereas, in HP group,

Table 2. Classification of subjects in normal protein (NP) and high protein (HP) groups according to their satiety scores

Meals	Satiety scores					
	4 or less		5 – 7		8 or more	
	Number	Per cent	Number	Per cent	Number	Per cent
NP (n = 14)						
Early morning	-	-	14	100	-	-
Breakfast	-	-	14	100	-	-
Mid morning	9	64	5	36	-	-
Lunch	-	-	14	100	-	-
Evening tea	-	-	14	100	-	-
Dinner	-	-	14	100	-	-
Post dinner	-	-	14	100	-	-
HP (n = 30)						
Early morning	-	-	30	100	-	-
Breakfast	-	-	30	100	-	-
Mid morning	-	-	30	100	-	-
Lunch	-	-	27	90	3	10
Evening tea	-	-	30	100	-	-
Dinner	-	-	30	100	-	-
Post dinner	-	-	24	80	6	20

Table 3. Per cent compliance to meals of the designed diets by the subjects in normal protein (NP), high protein (HP) and high protein + exercise (HP+E) groups

Meal	NP (n = 15)	HP (n = 16)	HP+E (n = 14)	CD at 5%
Early morning	52.3 ± 13.2^{ab}	86.7 ± 10.5^{ac}	79.7 ± 11.9^{bc}	6.15
Breakfast	87.5 ± 6.6^{ab}	95.2 ± 6.1^{a}	95.9 ± 7.2^{b}	3.43
Mid morning	47.1 ± 9.9^{ab}	81.1 ± 8.5^{ac}	96.1 ± 6.2^{bc}	4.32
Lunch	90.3 ± 6.3^{ab}	78.4 ± 8.0^{a}	75.8 ± 7.7^{b}	3.83
Evening tea	75.3 ± 9.4^{b}	73.7 ± 9.1^{c}	81.0 ± 7.9^{bc}	4.57
Dinner	75.8 ± 8.2^{a}	82.5 ± 7.6^{ac}	71.6 ± 8.6^{c}	4.22
Post dinner	35.8 ± 9.6^{ab}	78.8 ± 10.6^{a}	79.2 ± 12.6^{b}	5.56
Walk	-	-	60.2 ± 7.8	-
Exercise	-	-	23.8 ± 4.9	-

a : significant difference between NP and HP
b : significant difference between NP and HP+E
c : significant difference between HP and HP+E
NS= Non-significant

the maximum compliance was for breakfast (95.2%) and the minimum compliance was for evening tea (73.7%). HP+E group showed maximum compliance for mid morning meal (96.1%) closely followed by breakfast (95.9%) and dinner had minimum compliance of 71.6%. Among the two exercise categories, walk had a better compliance (60.2%). The resistance exercise had quite a poor compliance *i.e.* 23.8% as the selected subjects in the HP+E group were not in the habit of doing this kind of exercise.

A significantly (p = 0.05) higher compliance was observed in HP+E group when compared to HP group for breakfast, mid morning and evening tea while compliance for early morning and dinner was significantly (p = 0.05) higher in HP group. NP group had significantly (p = 0.05) lower compliance for four meals *i.e.* early morning, breakfast, mid morning and post dinner as compared to HP and HP+E group. The results indicated that HP group had higher compliance per cent as compared to NP group, thus highlighted that it was easier to follow the weight reducing diets with higher protein. The results further revealed that compliance of exercise was much lower than the designed diets, indicating that dietary modifications were easier to follow by the subjects when compared to prescribe exercise schedule.

The level of difficulty faced by the subjects in three groups during the adoption of designed diets was assessed by using a 6-point scale varying from slightly difficult (1) to easy (6). Fig. 1 shows that the highest score of 5.4 and 5.2 was achieved by HP+E and HP groups, respectively, however significant (p = 0.05) lower scores were observed in NP group (3.6) indicating that HP diet plans were easier to follow.

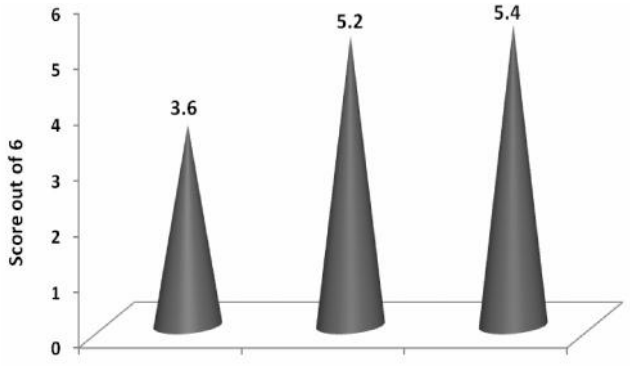

Fig. 1. Level of difficulty faced in following diets by the subjects in normal protein (NP), high protein (HP) and high protein + exercise (HP+E) groups

Fig. 2 shows that maximum compliance of diets was during the weekdays, the compliance being 67, 100 and 100% observed in NP, HP and HP+E groups, respectively. HP and HP+E groups showed very low compliance on weekends, the corresponding values being 18.8 and 35.7%. NP group had compliance of 53.5% among subjects during weekends. The findings revealed that subjects in HP and HP+E groups followed

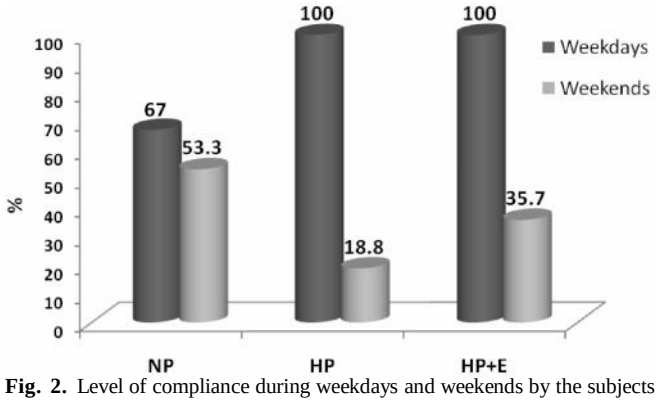

Fig. 2. Level of compliance during weekdays and weekends by the subjects in control, normal protein (NP), high protein (HP) and high protein + exercise (HP+E) groups.

diets strictly during weekdays, however, both groups showed lesser compliance during weekends as compared to NP group.

The study concluded that the satiety scores and compliance of designed high protein diets were higher than the normal protein diet for most of the meals. Therefore, high protein hypocaloric diet is a better approach in weight loss regimen as it imparts more satiety and has better compliance.

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