The Effect of Gum Arabic on Blood Glycemia, Blood Lipidemia, Body Composition and Gastrointestinal Tract in UAE Adults at Risk of Metabolic Syndrome

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College of Food and Agriculture
Food, Nutrition and Health Department
The University of The Future

- Established in 1976
- First University in the UAE
- 14,000 students
- 9 colleges
- 9 research centers & institutes
- 1 Science & Innovation Park
- Students from 64 countries

QS Rankings (2018)
Outline

- Introduction
- Literature Review
- Hypothesis and Objectives
- Methodology
- Results and Discussion
- Conclusion
- References
Introduction
Metabolic syndrome is a cluster of disorders linked with obesity and hyperinsulinemia, and associated with a markedly increased risk of type 2 diabetes and Cardiovascular diseases (CVD)
Metabolic Syndrome Prevalence

World
20-25% adults in world’s population
(IDF, 2006)

UAE
40.5% of UAE adults population, among women (45.9%) and the men (32.9%) (Malik & Razig, 2008)
34.5% of UAE adults population, among (17-25 years) obese females (Al Dhaeri et al., 2016)
Gum Arabic

Soluble dietary fiber obtained from the stems and branches of Acacia Senegal and Seyal.

95% of complex polysaccharides, 2% proteins, and contains calcium, magnesium, potassium, its pH 4.5–5.

Consumed to improve digestive comfort and intestinal transit.
Safety of Gum Arabic

FDA has listed GA as a direct food additive, and it’s used as:
- Emulsifier
- Flavoring agent

JECFA, confirmed the acceptable daily intake (ADI) of Gum Arabic as “Not specified”, a substance of very low toxicity.

(Food and Drug Administration, 2001 & Food and Drug Research Laboratories, 1972)

JECFA (Joint FAO/WHO Expert Committee on Food Additives)
Literature Review

GUM ACACIA
The effect of Gum Arabic on

- Weight Management
- Lipid profile
- Bowel Movement
- Blood pressure
- Blood glucose
Effects of Gum Arabic on Lipid profile

Dosage:
30 g/day of GA for 4 weeks.

Results:
- Reduced their serum cholesterol by 10.4%.
- LDL and VLDL cholesterol were reduced significantly ($P < 0.05$).
- Little effect on HDL and triglycerides.
Effects of Gum Arabic on Lipid profile

Participants:
- 5 healthy male volunteers.

Dosage:
- 25 g of GA/day for three weeks

Results:
- Significant ($P <0.05$) reduction on total serum cholesterol concentration.
- No significant changes were seen in triglyceride concentrations.

A study of the effects of dietary gum arabic in humans

A H M Ross, M A Eastwood, W G Brydon, J R Anderson, D M W Anderson

The American Journal of Clinical Nutrition, Volume 37, Issue 3, 1 March 1983, Pages 368–375,
https://doi.org/10.1093/ajcn/37.3.368
Effects of Gum Arabic on Weight Management (satiety and food intake)

Study 1:
- Participant= 12 males
- Doses: (10- 20- 40 grams) of GA

Study 2:
- Participant= 42 Female, 16 Male
- Doses: (5-10 grams) of GA

Result:
- All of the doses given approved that gum Arabic is effective in increasing satiety rates, and therefore it helps in reducing energy intake
Effects of Gum Arabic on Bowel Movement: Fecal incontinence

Participants:
- 42 adults

Dosage:
- 25 g of GA/day for three weeks

Results:
- There was a significant ($P < 0.02$) reduction in incontinent stools and improvement of stool consistency
Effects of Gum Arabic on Blood Glucose Level

Participants:
• 5 healthy male volunteers.

Dosage:
• 28 g acetogenic fibers (a blend of 20% pectin and 80% acacia gum) for 5 weeks.

Result:
• Fasting blood glucose was significantly \((P < 0.05)\) reduced after fiber treatment compared with control.
Effects of Gum Arabic on Blood pressure

Participants:
- 47 volunteers.

Dosage:
- 25 g/day of SUPERGUM™ for 8-12 weeks.

Result:
- Blood pressure was significantly ($P < 0.01$) reduced after SUPERGUM™ treatment compared with control
Hypothesis

GUM ACACIA
Hypothesis

Consumption of 20 grams of Gum Arabic reduces abdominal obesity, blood glucose, blood pressure and improve lipid profile and hence reduces the risk of developing metabolic syndrome.
Objective

GUM ACACIA
Objective:

To measure the effect of 20 grams of Gum Arabic powder for 12 weeks on:

- Blood Glycaemia
- Blood Lipidemia
- Body Composition
- Gastrointestinal Motility
Methodology
Participants

Recruitment

- Advertisement in social media.
- Advertisement posters in hostel & university.
- Asking students & workers in the canteen.

Inclusion criteria

- 18-50 YO Females and males.
- Who are at risk of developing metabolic syndrome.
- Have 2 out of 5 risk factors of MetS.

Exclusion criteria

- Lifestyle Changes.
- Permanent Medication: hypertensive, lipid.
- Females: pregnancy or lactation.
Study Design

- A controlled, randomized, single blind, parallel-design study.
- For 12 weeks.
Figure (1): Flow chart of study design including baseline and endpoint

**Inclusion criteria:**
Who are at risk of developing metabolic syndrome.
Have 2 out of 5 risk factors of METs

**Exclusion criteria:**
Pregnant / lactating female,
Permanent medication: hypertension, lipid and lifestyle changes.

**Baseline week 0 (n=72 participants)**

11 participants drop out due to low commitment

**Baseline week 0 (n=61 participants)**

**Control week 12 (n=30 participants)**

**Intervention week 12 (n=31 participants)**
Approved

This study was ethically approved by the UAEU Human Research Ethics Committee (AAMDHREC).
APPENDIX 2: CONSENT FORM

Title of project: The Effect of Gum Arabic on Blood Glycaemia, Blood Lipidemia, Body Composition and Gastrointestinal Tract on Adults in UAE at Risk of Metabolic Syndrome: Single-blind randomized parallel study

Names of researchers: Dr. Ayesha Al Al Diskier

Please initial the appropriate box:

1. I confirm that I have read and understand the information sheet for the above research project.

2. I confirm that I have had the opportunity to ask questions and have received satisfactory answers to all my questions.

3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reasons, or to withdraw any unprocessed data previously supplied.

4. I understand that confidentiality of information provided can only be protected within the limits of the law.

5. I agree to take part in the above study.

Name of participant
Name of person taking consent
Name of witness (of subject unable to read/write)
Name of parent guardian of child (where subject unable to give consent due to age or incapacity)

Date
Signature

Date
Signature

Date
Signature

Date
Signature
APPENDIX 3: INFORMATION SHEET

The Effect of Gum Arabic on Blood Lipidemia, Body Composition and Gastrointestinal Tract in Adults in UAE at Risk of Metabolic Syndrome: A Single, blind, randomized parallel study

You are being invited to take part in a research study. Before you decide, it is important that you understand why the research is being done and what it involves. Please make sure that you read the following information carefully.

What is the purpose of the study?
This study aims to investigate the relationship between gum Arabic consumption and the risk of developing metabolic syndrome. The objectives of the study are to evaluate the effect of gum Arabic on fasting blood glucose, BMI, and blood pressure. The study will be a single-blind, randomized controlled trial, and the participants will be studied for the following metabolic syndromes:

- Hyperglycemia (fasting blood glucose levels greater than 126 mg/dL)
- Elevated triglycerides (fasting triglyceride levels greater than 150 mg/dL)
- Elevated HDL cholesterol levels

Why have I been chosen to take part?
The subjects chosen to take part in the study are adults aged 18-50 years, UAEU students and staff. Subjects must have at least 7 of the metabolic syndrome criteria including:

- Elevated waist circumference (according to the IDF – European chart)
- Men — greater than 94 cm
- Women — greater than 80 cm
- Elevated triglycerides (fasting levels greater than 150 mg/dL)
- Elevated HDL cholesterol levels
- Elevated blood pressure levels

Are there any risks involved?
During each study visit, the participants will be monitored for any adverse effects. At any stage, if you feel unwell, you may withdraw from the study. During the course of the study, if you are identified as being at risk of developing diabetes or any other adverse effects, you will be provided with medical information and given similar to that in your physician. It must be stressed that this is not a risk of developing diabetes

What are the possible benefits of taking part?
You will receive your own health check profile, including anthropometric and body composition measurements. As a show of appreciation, you will receive a certificate.

What will happen to the results of the study?
Confidentiality of information provided can only be protected within the limitations of the law. All information collected will be kept strictly confidential. All samples and records will be coded and only be available to the researchers involved in the study. Your name will never appear in any published works. The Deanship of Health Sciences and Research will carry out data analysis and dissemination of results. All data from the study will be stored by the Department of Statistics and Handicraft and will be shared in the Department for a maximum of 3 years.
Screening Measurements

- **Anthropometric**
  - Waist circumference
    - M: >94 cm
    - F: >80 cm

- **Clinical**
  - Blood Pressure
    - ≥130/85 mm Hg

- **Biochemical**
  - Fasting Blood glucose
    - ≥100 mg/dL
  - HDL cholesterol
    - M: < 40 mg/dL
    - F: < 50 mg/dL
  - Triglycerides
    - ≥ 150 mg/dL
Data Collection and Analysis

**Anthropometric Measurements**
- Body weight (Kg)
- Height (cm)
- Waist circumference (cm)
- Body composition (InBody 720)

**Assessment of food intake**
- Food records (3 Day/period)
- ESHA food analysis program (version 10.4) that includes Kuwaiti Food Composition database

**Biochemical measurements**
- HemoCue: (Blood glucose, HbA1c)
- Cobas: (Lipid profile)

**Clinical measurement**
- Blood pressure (Digital blood pressure monitor HEM907)
Data Collection and Analysis

Questionnaires

IPAQ

Satiety Questionnaire

Bowel motion Questionnaire
APPENDIX6: INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

(August 2002)

SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-65 years)

The International Physical Activity Questionnaire (IPAQ) comprises a set of questions. Long form activity data is collected independently, and short form surveys for use by either telephone or self-administered formats are available. The purpose of the questionnaires is to provide data that can be used to obtain internationally comparable data on health-related physical activity.

Background on IPAQ

The development of a tool for physical activity (IPAQ) research in Germany was made possible through the support of the Federal Ministry of Health and Family Policy and the Federal Ministry of Education and Science. The instrument was developed to assess physical activity levels in a population-based sample of German adults. The IPAQ is a self-administered questionnaire that measures physical activity over a specified period of time.

Using IPAQ

The IPAQ can be used to assess physical activity levels in a population-based sample of German adults. The tool provides a standardized method for assessing physical activity levels in a population-based sample of German adults. The IPAQ is a self-administered questionnaire that measures physical activity over a specified period of time.

Further Developments

International collaboration on IPAQ is ongoing and an International Physical Activity Questionnaire Prevalence Study is in progress. For further information see the IPAQ website.

More Information

More detailed information on the IPAQ's development and use can be obtained from the website: www.ipaq.ki.se. Other scientific publications and presentations on the use of IPAQ are summarized on the website.
Satiety Questionnaire

1 - Before sehur meal time immediately
   [Diagram with levels of hunger]

2 - After 15 min of sehur meal time
   [Diagram with levels of hunger]

3 - At wakeup immediately
   [Diagram with levels of hunger]

4 - At 12:00 PM
   [Diagram with levels of hunger]

5 - Before iftar meal time (around 5:15 PM)
   [Diagram with levels of hunger]

6 - At iftar time immediately
   [Diagram with levels of hunger]
Gastrointestinal questionnaire

1. Did you experience reduced feeling in the last week?
   - Yes: ___________
   - No: ___________

2. How would you describe your usual bowel pattern in the last week?
   - Normal: ___________
   - Constipated: ___________
   - Diarrhea: ___________
   - Alternating (constipation and diarrhea): ___________

3. Did you experience any change in your bowel motion during last Ramadan (one year back)?
   - Yes: ___________
   - No: ___________

4. How many bowel movements did you last week?
   - 1 or less: ___________
   - 2-3: ___________
   - 4-5: ___________
   - 6-7: ___________

5. What did you experience more during last Ramadan (Baseline)?
   - Normal: ___________
   - Constipated: ___________
   - Diarrhea: ___________

6. How many bowel movements did you last week?
   - 1 or less: ___________
   - 2-3: ___________
   - 4-5: ___________
   - 6-7: ___________

7. Did you experience a reduction in bloating during Ramadan after the ingestion of high-fiber cereal (intervention)?
   - Yes: ___________
   - No: ___________

8. How many times have you had a feeling of bloating during the last week?
   - 1 or less: ___________
   - 2-3: ___________
   - 4-5: ___________
   - 6-7: ___________

9. Did you experience bloating during last Ramadan (one year back)?
   - Yes: ___________
   - No: ___________

10. How many times have you had a feeling of bloating during Ramadan after the ingestion of high-fiber cereal (intervention)?
    - Yes: ___________
    - No: ___________

11. Based on your Nutritional Information do you think that high fiber foods can help constipation?
    - Yes: ___________
    - No: ___________

12. How many times have you had a feeling of bloating during Ramadan?
    - 1 or less: ___________
    - 2-3: ___________
    - 4-5: ___________
    - 6-7: ___________

13. Did you experience a reduction in bloating during Ramadan after the ingestion of high-fiber cereal (intervention)?
    - Yes: ___________
    - No: ___________

14. How many times have you had a feeling of bloating during Ramadan after the ingestion of high-fiber cereal (intervention)?
    - Yes: ___________
    - No: ___________

15. How many times have you had a feeling of bloating during Ramadan after the ingestion of high-fiber cereal (intervention)?
    - Yes: ___________
    - No: ___________
APPENDIX 4: Food diary (Arabic & English)

Do you think that you have eaten as you would do usually?

YES ☐ ☐ NO ☑ ☑

If Not, then why not? i.e. were you ill, on holiday, etc.
------------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------------

Subject code: ____________________________

Food Diary

Day 1: _______
Day 2: _______
Day 3: _______
### Food Diary

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
<th>Calories</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrates (g)</th>
<th>Fiber (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:15am</td>
<td>Whole grain bread</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:30am</td>
<td>Tea with milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00am</td>
<td>Tea with milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:30am</td>
<td>Banana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30pm</td>
<td>Whole wheat bread</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00pm</td>
<td>Glass of water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- 2 slices of bread
- Thin spread
- 1 large
- Small
- Medium
- All
- 1 medium
- Large

**Sample Menu:**
- Whole wheat bread
- Glass of water

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### Additional Information

- **Calories:**
  - Whole grain bread: 0
  - Tea with milk: 0
  - Banana: 0
  - Whole wheat bread: 0
  - Glass of water: 0

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**Food Diary Entry:**

<table>
<thead>
<tr>
<th>Meal</th>
<th>Description</th>
<th>Calories</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrates (g)</th>
<th>Fiber (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>Whole grain bread</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Breakfast</td>
<td>Glass of water</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lunch</td>
<td>Whole wheat bread</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lunch</td>
<td>Tea with milk</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Snack</td>
<td>Tea with milk</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Snack</td>
<td>Banana</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dinner</td>
<td>Tea with milk</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dinner</td>
<td>Whole wheat bread</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dinner</td>
<td>Glass of water</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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**Total Calories:**

- Breakfast: 0
- Lunch: 0
- Snack: 0
- Dinner: 0

**Total Nutrients:**

- Calories: 0
- Protein: 0 g
- Fat: 0 g
- Carbohydrates: 0 g
- Fiber: 0 g
Statistical Analysis

- **G*Power** 3.1.9.2 software was used for sample size calculation for repeated measures ANOVA with parallel design. The calculation revealed the need for a sample size of at least 54 participants to detect a medium effect size (0.25) with significance level set at 0.05 and power as 0.95.

- Statistical analysis was performed using SPSS version 24.0, and results presented as (Mean ± Standard Deviation). A repeated measures ANOVA was used to detect main effects of time and group on study measures. **Paired t-test** and independent **t-test** were employed to compare time effect and groups (Control vs. Intervention) respectively. Results were considered statistically significant at P-value < 0.05.
Results

GUM ACACIA
Table 1: Physical characteristics of the total study population, (N=61).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>25.51 ± 9.50</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>94.20 ± 18.60</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.90 ± 9.90</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>33.90 ± 5.40</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>100.90 ± 13.60</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td>43.10 ± 7.90</td>
</tr>
<tr>
<td>Systolic (mm Hg)</td>
<td>118.94 ± 16.12</td>
</tr>
<tr>
<td>Diastolic (mm Hg)</td>
<td>79.75 ± 9.98</td>
</tr>
<tr>
<td>Variable</td>
<td>Baseline</td>
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<tr>
<td>-------------------------------</td>
<td>---------------------------</td>
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<tr>
<td>Age (years)</td>
<td>25.85 ± 9.90</td>
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<tr>
<td>Weight (kg)</td>
<td>91.74 ± 20.80</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.30 ± 11.60</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>31.92 ± 4.70</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>100.50 ± 16.10</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td>39.72 ± 8.40</td>
</tr>
<tr>
<td>Body Fat Free Mass (kg)</td>
<td>53.79 ± 14.50</td>
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<tr>
<td>Total body water (L)</td>
<td>41.05 ± 11.70</td>
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<tr>
<td>Systolic (mm Hg)</td>
<td>114.80 ± 16.40</td>
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<tr>
<td>Diastolic (mm Hg)</td>
<td>75.8 ± 9.90</td>
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</table>

- ¹average of 3 day record
- ²difference in the control group between baseline and endpoint.
- ³difference in the intervention group between baseline and endpoint.
- *Endpoint Intervention significantly different from Baseline Intervention, (P<0.05).
Table 3: Dietary¹ and physical activity characteristics of the study population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th></th>
<th></th>
<th>Endpoint</th>
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<th>P-value (C²</th>
<th>I¹³</th>
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</thead>
<tbody>
<tr>
<td>Vigorous (min/wk)</td>
<td>Control (C) 11.1 ± 26.9</td>
<td>Intervention (I) 14.4 ± 28.2</td>
<td>0.683</td>
<td>Control (C) 10.7 ± 24.4</td>
<td>Intervention (I) 18.4 ± 52.9</td>
<td>0.55</td>
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<tr>
<td>Moderate (min/wk)</td>
<td>Control (C) 59.4 ± 50.7</td>
<td>Intervention (I) 62.1 ± 78.9</td>
<td>0.117</td>
<td>Control (C) 71.5 ± 146.9</td>
<td>Intervention (I) 59.1 ± 90.5</td>
<td>0.709</td>
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<td>Light (min/wk)</td>
<td>Control (C) 190.2 ± 116.10</td>
<td>Intervention (I) 193.5 ± 28.80</td>
<td>0.939</td>
<td>Control (C) 206.5 ± 125.90</td>
<td>Intervention (I) 198.4 ± 182.4</td>
<td>0.863</td>
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<tr>
<td>Sedentary Activity (hr/d)</td>
<td>Control (C) 9.20 ± 3.30</td>
<td>Intervention (I) 10.5 ± 3.1</td>
<td>0.155</td>
<td>Control (C) 10.9 ± 3.5</td>
<td>Intervention (I) 10.7 ± 3.8</td>
<td>0.847</td>
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<tr>
<td>Energy (kcal)</td>
<td>Control (C) 2142 ± 551.8</td>
<td>Intervention (I) 2036.9 ± 601.5</td>
<td>0.534</td>
<td>Control (C) 2092 ± 486.2</td>
<td>Intervention (I) 1810 ± 554.3</td>
<td>0.069</td>
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<tr>
<td>Carbohydrate (g)</td>
<td>Control (C) 256 ± 57.7</td>
<td>Intervention (I) 239.4 ± 84.3</td>
<td>0.446</td>
<td>Control (C) 256 ± 59.3</td>
<td>Intervention (I) 194 ± 78.0</td>
<td>0.004</td>
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<tr>
<td>Fat (g)</td>
<td>Control (C) 82.2 ± 34.1</td>
<td>Intervention (I) 80.5 ± 30.7</td>
<td>0.852</td>
<td>Control (C) 73.2 ± 27.6</td>
<td>Intervention (I) 71.3 ± 28.1</td>
<td>0.815</td>
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<tr>
<td>Protein (g)</td>
<td>Control (C) 81.7 ± 28.9</td>
<td>Intervention (I) 86.9 ± 38.4</td>
<td>0.609</td>
<td>Control (C) 87 ± 31.5</td>
<td>Intervention (I) 84.9 ± 45.6</td>
<td>0.854</td>
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<tr>
<td>Dietary fiber (g)</td>
<td>Control (C) 15.0 ± 9.8</td>
<td>Intervention (I) 17.1 ± 15.2</td>
<td>0.648</td>
<td>Control (C) 16.1 ± 10.9</td>
<td>Intervention (I) 31.9 ± 14.6</td>
<td>&lt;0.001</td>
<td></td>
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</tr>
</tbody>
</table>

- ¹ average of 3 day record
- ² difference in the control group between baseline and endpoint.
- ³ difference in the intervention group between baseline and endpoint.
- *Endpoint Intervention significantly different from Baseline Intervention, (P<0.05).
Table 4: Biochemical measurements of study population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th>Endpoint</th>
<th>P-value</th>
<th>Baseline</th>
<th>Endpoint</th>
<th>P-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (C)</td>
<td>Intervention (I)</td>
<td>P-value</td>
<td>Control (C)</td>
<td>Intervention (I)</td>
<td>P-value</td>
<td>C¹</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>6.10±0.90</td>
<td>6.0±1.7</td>
<td>0.763</td>
<td>6.0±0.4</td>
<td>6.00±0.8</td>
<td>0.938</td>
<td>0.662</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>101.50±14.00</td>
<td>105.6±36.0</td>
<td>0.635</td>
<td>99.5±14.2</td>
<td>92.90±13.20*</td>
<td>0.101</td>
<td>0.489</td>
</tr>
<tr>
<td>Triglycerides (mg/dl)</td>
<td>94.70±41.60</td>
<td>100.9±53.9</td>
<td>0.661</td>
<td>94.9±41.0</td>
<td>93.90±44.0</td>
<td>0.936</td>
<td>0.955</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>150.7±34.30</td>
<td>157.9±28.20</td>
<td>0.413</td>
<td>151.2±37.8</td>
<td>152.60±30.6</td>
<td>0.892</td>
<td>0.941</td>
</tr>
<tr>
<td>LDL (mmol/dl)</td>
<td>2.50±0.90</td>
<td>2.50±0.70</td>
<td>0.926</td>
<td>2.3±0.8</td>
<td>2.4±0.7</td>
<td>0.625</td>
<td>0.433</td>
</tr>
<tr>
<td>HDL (mg/dl)</td>
<td>46.3±12.1</td>
<td>45.1±12.1</td>
<td>0.747</td>
<td>46.2±13.2</td>
<td>44.8±13.9</td>
<td>0.736</td>
<td>0.951</td>
</tr>
</tbody>
</table>

*Endpoint Intervention significantly different from Baseline Intervention, (P<0.05).
¹ Difference in the control group between Baseline and Endpoint.
² Difference in the intervention group between Baseline and Endpoint.
Table 5: The effect of GA on the bowel motion after 12 weeks

<table>
<thead>
<tr>
<th>Response rate for</th>
<th>Endpoint</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (Yes, %)</td>
<td>Intervention (Yes, %)</td>
<td>P-value</td>
<td></td>
</tr>
<tr>
<td>Improvement of bowel motion</td>
<td>35.0</td>
<td>54.8</td>
<td>0.172</td>
<td></td>
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<tr>
<td>Reduction in bloating feelings</td>
<td>20.0</td>
<td>51.6</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td>Reduction in abdominal pain</td>
<td>10.0</td>
<td>22.6</td>
<td>0.259</td>
<td></td>
</tr>
<tr>
<td>Feeling of better digestion</td>
<td>25.0</td>
<td>41.9</td>
<td>0.225</td>
<td></td>
</tr>
<tr>
<td>Reduction in nausea</td>
<td>10.0</td>
<td>25.8</td>
<td>0.172</td>
<td></td>
</tr>
</tbody>
</table>
Figure 3: Average appetite score following 60 min of ingestion of tested foods (pectin vs. GA-AS).
Conclusion

Ingestion of 20 g of GA-AS for 12 weeks significantly reduced energy and carbohydrate intakes, and improved blood pressure, blood glucose and bowel motion.

Satiety was improved after 1hr of consumption of GA-AS.

Limitation: many participants reported facing difficulties in the solubility of GA-AS
Research Team

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References:


Thank you