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Impacts of Genetically Modified Food on Insulin Hormone, Glucose, and Lipid Profile of Male and Female Wister Albino Rats

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Abstract:

In recent years, genetically modified (GM) crops aim to produce food \ and feed which has become part of the usual agriculture in many areas of the world. Whether GM food and feed have positive or negative impacts on humans or animals is still unclear. Therefore, an investigation of the effects of different diets containing genetically modified food (GMF) on insulin hormone, glucose, and lipid profile were carried out in the present study. Male and female Wister Albino rats70-80 g range body weight was used in the present study. Each sex was divided into 4 groups (n = 10 per group). Control group fed on the basal diet American Institute of Nutrition for Growth (AIN93 G) and three treated groups were given GM (corn, wheat, and rice) and water adlibitum for three months. The reason for choosing these foods is because they are the most basic foods consumed in our daily life (bread and rice). At the end of the experimental period results compared to the control group GM (corn, wheat, and rice) for both sexes showed a significant decrease in serum insulin and the significant increase in serum glucose. Also, significant increase in total cholesterol (TC) , triglycerides (TG), low density lipoprotein-cholesterol (LDL-C), very low density lipoproteins (VLDL), Risk ratio I and Risk ratio II. Yet, serum high density lipoproteins cholesterol (HDL-C) levels showed significant decrease in all groups. Body weight showed a significant increase in all groups of males and female rats.

Keywords: genetically modified food, insulin hormone, glucose, lipid profile, albino rats.

Introduction

GMFs are an ongoing problem in the world today. In accordance with the World Health Organization (WHO), GMFs back to the foods taken from GM material DNA that has been modified somehow that does not occur naturally (by transferring genes or adding specific genes from a different organism into crops), while old traditional methods like hybridization and tissue culture with proteins are more natural [1,2]. Scientists are able to genetically

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engineer food to meet specific nutritional needs or increase crop yields to feed the growing world population, expected to reach 9 billion by 2050.Thereafter, agricultural growth experienced in alternative methods to boost the quality, diversity, and pest-resistance of agriculture products. These experiments led to the expansion of the biotechnology agricultural sector, which served as a good ground for GMF research and cultivation and set out to establish GMF into the daily food of most consumers [3,4]. Changes arise through new processes and novel products often improving some lifestyle dimensions but also making some others worse. The idea that food, the fuel of the body and brain, is being altered or modified can be unsettling [5,6].

The principal crops are wheat, rice, maize, and sugarcane. Government policy aims to strengthen agriculture as an important part of the economy by promoting privatization and reducing state control and subsidies. The main challenges for agricultural development in Egypt are the limited arable land base, erosion of land resources, loss of soil fertility and salinity and high population growth of 1.9% annually [7,8].

Today, scientists can incorporate new genes from one species into a completely unrelated species through genetic engineering. The term GMFs are used interchangeably with genetically modified organisms (GMOs) and GM crops [9,10].

Genetic engineering studies have developed cereals and oilseeds with improved proteins, carbohydrates, oil, vitamins, minerals, fibers, and phytochemicals for food, feed, and industrial application [11].

Do genetic engineering products produce long- term effects?

Are genetically engineered foods safe for human and animal consumption?

Knowledge from different researches did not provide consumers with a definitive answer to the questions.

In previous studies, serum glucose showed a significant decrease in rats fed on GM rice compared to the control group [12]. Also, level of glucose was significantly lower in animals fed GM maize [13]. But significant increase in serum glucose of GM corn group compared to control group [14].

GM soybean reduced TC and TG levels in human [15], and in hamsters [16]**.** Serum TG was significantly increased in rat fed on GM maize [13]. In addition**,** the TC, HDL, LDL were higher in female rats consuming the transgenic rice diet than those consuming the conventional rice diet**,** while **TG** showed no difference in different groups [17]. Also, GM rice significantly decreased serum TG but had no effect on serum TC, LDL and HDL [18].

Pigs fed on GM maize had heavier body weight than non-GM group [19]. In addition, body weight increased in female rats fed on GM maize group [13]. In contrast**,** GM soya bean significantly reduced body weight [20,21].

So, the question of whether or not GMF is safe or harmful to human health remains unresolved.

Material and Methods

Male and female Wister Albino rats weighing between 70 and 80 g were obtained from the private market Abou-Rawash, Giza, Egypt, and used in the present study. Rats were housed in stainless steel cages and kept in the animal facility for two days before enrollment in the study. They were kept on the standard diet (AIN 93 G) and water adlibitum, and maintained in conditions of good ventilation, normal temperature, and humidity range. After acclimatization, each sex of rats was divided into four groups: -

Group (I): Control group, rats fed on the basal diet (AIN 93 G) for three months.

Group (II): Corn group, rats fed on GM corn (binary hybrid) that was obtained from Agriculture Research Center incorporated as 50% in AIN-93G diet for three months.

Group (III): Wheat group, rats fed on GM wheat (misr1) that was obtained from Agriculture Research Center incorporated as 50% in AIN-93G diet for three months.

Group (IV): Rice group, rats fed on GM rice (sakha101) that was obtained from Agriculture Research Center incorporated as 50% in AIN93G diet for three months.

At the end of the experimental period, rats were anesthetized using diethyl ether; the blood was obtained from the rats orbit plexus into a clean centrifuge tube and left at room temperature in an oblique position for two hours to coagulate. After complete retraction of the clot, the clean serum was obtained by centrifugation at 3,000 r.p.m. for 20 minutes.

The supernatant serum was carefully decanted in clean epindorve and frozen at-20°C until use for the estimation of biochemical analysis.

Analysis:

Determination of insulin was measured by using the Electrochemiluminescence Immunoassay “ECLIA” intended for use on Elecsys and Cobas e Immunoassay analyzers [22]. TC level in serum samples were measured by Synchron CX4 according to the method of [23].

HDL-C and LDL-C level were measured by Synchron CX4 according to [24], also serum TG and glucose levels were estimated by Synchron CX4 depending on assay depicted by [25,26] respectively. Body weights of rats were recorded before and after the experimental period.

Statistical analysis:

All data were analyzed using the IBM SPSS for windows version 18.0 [27]. Independent sample t-test was used to calculate statistical significance between the control group and GM (corn, wheat, and rice) groups. The level of significance was set as P< 0.05 for all statistical tests.

Results

Data present in table (I) show effect of GMF for three months on serum insulin hormone and glucose of male rats.

The present study showed significant decrease of insulin hormone in GM (corn, wheat, and rice) with (-58.5%, -24.4%, -34.1%) respectively compared to control group. On the other hand, glucose level showed significant increase in GM (corn, wheat, and rice) with (40.4%, 33.0%, 15.0%) respectively compared to control group.

Table (I): Effect of Genetic Modified Food for Three Months on Serum Insulin Hormone and Glucose of Male Rats.

Parameters / Groups		Insulin hormone (pmol/L)	Serum glucose (mg/dl)
Control group	**Range**	**0.21 — 0.55**	**98.0 — 118.0**
	Mean ± S.E	**0.41 ± 0.04**	**111.1 ± 2.83**
GM Corn group	**Range**	**0.12 — 0.32**	**141.0 — 173.0**
	Mean ± S.E	**0.17 ± 0.021**	**156.0 ± 3.03**
	% of change	**-58.5**	**40.4**
	P value	**P < 0.001**	**P < 0.001**
GM Wheat group	**Range**	**0.016 — 0.39**	**136.0 — 166**
	Mean ± S.E	**0.31 ± 0.03**	**147.8 ± 3.51**
	% of change	**-24.4**	**33.0**
	P value	**P < 0.05**	**P < 0.001**
	Range	**0.12 — 0.39**	**99.0 — 146.0**

GM Rice group	Mean ± S.E	0.27 ± 0.35	127.8 ± 4.5
	% of change	-34.1	15.0
	P value	P < 0.05	P < 0.05

P= probability N.S.= non significant S.E.= standard error

Data present in table (II) show effect of GMF for three months on serum insulin hormone and glucose of female rats.

The present study showed significant decrease of insulin hormone in GM (corn, wheat, and rice) with (-64.1% , -38.5% , -61.5%) respectively compared to control group. On the other hand, glucose level showed significant increase in GM (corn, wheat, and rice) with (56.9% , 48.1% , 21.6%) respectively compared to control group.

Table (II): Effect of Genetic Modified Food for Three Months on Serum Insulin Hormone and Glucose of Female Rats.

Parameters / Groups		Insulin hormone (pmol/L)	Serum glucose (mg/dl)
Control group	Range	0.19 — 0.56	98.0 — 112.0
	Mean ± S.E	0.39 ± 0.03	104.3 ± 1.41
GM Corn group	Range	0.07 — 0.31	144.0 — 181.0
	Mean ± S.E	0.14 ± 0.03	163.7 ± 4.7
	% of change	- 64.1	56.9
	P value	P < 0.001	P < 0.001
GM Wheat group	Range	0.11 — 0.33	142.0 — 174.0
	Mean ± S.E	0.24 ± 0.024	154.5 ± 3.7
	% of change	- 38.5	48.1
	P value	P < 0.001	P < 0.001
GM Rice group	Range	0.04 — 0.28	98.0 — 140
	Mean ± S.E	0.15 ± 0.02	126.8 ± 4.3
	% of change	- 61.5	21.6
	P value	P < 0.001	P < 0.001

P= probability N.S.= non significant S.E.= standard error

Data present in table (III) show effect of GMF for three months on serum lipid profile and body weight of male rats.

Serum TC showed significant increase in GM (corn , wheat, and rice) with (52.9% , 22.1%, 59.3%) respectively compared to control group. Also , TG showed significant increase with (79.5%, 82.2%, 89.5%) respectively compared to control group . On the other hand , HDL level significantly decreased with (-33.1%, -12.4%, -38.6%) respectively compared to control group. However , LDL concentration showed an extremly significant increase in GM corn and GM rice with (224.8%, 255.1%) respectively and had significant increase in GM wheat with (87.6%) .Serum VLDL increased significantly in GM (corn and rice) with (80.3%, 89.8%) respectively, while a highly significant increase was observed in GM wheat group with (302.2%) compared to control group. Risk ratio I increased significantly with (45.3%) in GM wheat group, while highly significant increase with (115.5%, 143.1%) in GM (corn and rice) groups compared to control group. Risk ratio II showed highly significant increase in GM (corn , wheat ,and rice) groups with (389.4%, 140.4%, 474.5%) respectively compared to control group. Body weight of all three groups GM (corn, wheat, and rice) significantly increased with (36.4%, 52.5%, 41.5%) respectively compared to control group.

Table (III): Effect of Genetic Modified Food for Three Months on Serum Lipid Profile and Body Weight of Male Rats.

Parameters / Groups		TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)	Risk ratio I %	Risk ratio II %	Body weight (gm)
Control group	Range	93.0 —117.0	59.0—77.0	60.1 — 65.1	15.8 — 38.3	11.8 — 15.4	1.45 – 2.8	0.25 – 0.64	133.5 – 145
	Mean ± S.E	106.0 ± 2.28	68.7 ± 1.69	62.9 ± 0.60	29.37 ± 2.63	13.7 ± 0.34	1.81 ± 0.12	0.47 ± 0.045	138.6 ± 1.44
GM Corn group	Range	152.0— 117.0	112.0— 139.0	40.2 — 44.6	89.4 — 100.9	22.4 — 27.8	3.70 – 4.04	2.12- 2.45	182.4 – 200.8
	Mean ± S.E	162.1 ± 1.87	123.3 ± 2.8	42.1 ± 0.42	95.4 ± 1.35	24.7 ± 0.56	3.9 ± 0.04	2.3 ± 0.04	189.1 ± 1.82
	% of change	52.9	79.5	- 33.1	224.8	80.3	115.5	389.4	36.4
	P value	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001
GM Wheat group	Range	121.0 — 145.0	110.0 — 133.0	46.3 — 52.3	46.4 — 68.9	22 — 26.8	2.27 – 2.94	0.91 – 1.4	197.4 – 227
	Mean ± S.E	129.4 ± 2.71	125.2 ± 2.71	55.1 ± 2.33	55.11 ± 2.34	55.1 ± 2.34	2.63 ± 0.058	1.13 ± 0.05	211.3 ± 3.59
	% of change	22.1	82.2	- 12.4	87.6	302.2	45.3	140.4	52.5
	P value	P < 0.001	P < 0.001	P < 0.01	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001
GM Rice group	Range	115.0 — 187.0	112.0 — 137.0	37.8 — 39.9	89.1 — 120.1	22.4— 27.4	3.86 – 4.73	2.23 – 3.04	191.6 – 203
	Mean ± S.E	168.9 ± 3.13	130.2 ± 2.31	38.6 ± 0.29	104.3 ± 2.76	26.0 ± 0.46	4.4 ± 0.81	2.7 ± 0.07	196.1 ± 1.69
	% of change	59.3	89.5	- 38.6	255.1	89.8	143.1	474.5	41.5
	P value	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001

P= probability N.S.= non significant S.E.= standard error

Data present in table (IV) show effect of GMF for three months on serum lipid profile and body weight of female rats.

Serum TC showed significant increase in GM (corn, wheat, and rice) with (45.1%, 28.7%, 48.5%) respectively compared to control group. Also, TG showed significant increase with (72.2%, 72.2%, 85.2%) respectively compared to control group. On the other hand, HDL level significantly decreased with (-29.9%, -17.6%, -31.7%) respectively compared to control group. However, LDL concentration showed significant increase in GM (corn and rice) with (120.1%, 127.6%) respectively and showed significant increase in GM wheat with (87.6%). Risk ratio I increased significantly with (93.5% , 55.6% , 116.8%) in GM (corn, wheat and rice) groups respectively . Risk ratio II showed highly significant increase in GM (corn, wheat, and rice) groups with (213.9%, 108.1%, 234.9%) respectively compared to control group. Body weight of all three groups GM (corn, wheat, and rice) significantly increased with (33.9%, 44.1%, 38.8%) respectively compared to control group.

Table (IV): Effect of Genetic Modified Food for Three Months on Serum Lipid Profile and Body Weight of Female Rats.

Parameters / Groups		TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)	Risk ratio I %	Risk ratio II %	Body weight (gm)
Control group	Range	100.0— 127.00	69.0— 79.0	49.8 — 54.1	33.8 — 57.1	13.8 — 15.8	1.92 – 2.35	0.65 – 1.06	131.7 – 148
	Mean ± S.E	112.0 ± 2.86	73.5 ± 1.157	52.7 ± 0.52	45.3 ± 2.41	14.7 ± 0.231	2.41 ± 0.046	0.86 ± 0.043	139.6 ± 1.76
GM Corn group	Range	149.0— 174.0	112.0— 131.0	35.8 — 40.8	85.8 — 111.0	22.4 — 27.2	3.65 – 4.86	2.1 – 3.1	182.0 – 195.6
	Mean ± S.E	162.5 ± 2.43	126.6 ± 1.95	36.9 ± 0.502	99.7 ± 2.43	25.3 ± 0.39	4.41 ± 0.11	2.7 ± 0.09	187.0 ± 1.2
	% of change	45.1	72.2	- 29.9	120.1	72.1	93.5	213.9	33.9
	P value	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001
GM Wheat group	Range	130.0 — 159.0	111.0 — 132.0	40.3 — 48.4	65.2— 91.9	22.0 - 26.4	2.89 – 3.76	1.35 – 2.1	193.4 – 210.5
	Mean ± S.E	144.1 ± 2.44	126.6 ±1.95	43.4 ± 0.72	77.3 ± 2.61	23.4 ± 0.42	3.33 ± 0.083	1.79 ± 0.08	201.1 ± 1.89
	% of change	28.7	72.2	- 17.6	70.6	59.2	55.6	108.1	44.1
	P value	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001
GM Rice group	Range	158.0 — 179.0	129.0 — 142.0	33.1 — 39.1	93.5 — 116.8	25.8— 28.4	4.15 – 5.3	2.41 – 3.46	185.9 – 200.3
	Mean ± S.E	166.3 ± 2.37	136.1 ± 1.41	36.0± 0.64	103.1 ± 2.60	27.2 ± 0.28	4.64 ± 0.13	2.88 ± 0.12	193.7 ± 1.33

	% of change	**48.5**	**85.2**	**- 31.7**	**127.6**	**85.0**	**116.8**	**234.9**	**38.8**
	P value	**P < 0.001**	**P < 0.001**	**P < 0.001**	**P < 0.001**	**P < 0.001**	**P < 0.001**	**P < 0.001**	**P < 0.001**

P= probability N.S.= non significant S.E.= standard error

Discussion

Diabetes is one of the fastest growing health risks throughout the world, and the most notable approach to explore the disease has been the study of different genes and environmental factors that affect susceptibility to type I and type II diabetes.

Insulin hormone showed significant decrease in all groups in both sexes. On the other hand, glucose level showed significant increase in all groups. Likewise when serum insulin decrease ,the level of glucose will increase.

Increase in serum glucose may be also due to increased cortisol .Cortisol works on two different fronts, leading to increase levels of glucose in the blood. It motivates gluconeogenesis in the liver, and the glucose produced is released into the bloodstream and stored as glycogen. Also, by strengthening the impacts of epinephrine , it increases glycogenolysis in the liver, thus releasing a high level of glucose into the blood within minutes [28,29] , this correlates with a study carried out by the authors [30].

Another explanation for the increase of glucose, scientists observed that the starch content increased in GMF in wheat [31]**,** in corn [32] and in rice [33].

Rats fed on GMF had enlarged pancrease [34] , and as it was proved long ago in chronic pancreatitis the pancreas loses its ability to produce adequate insulin, and therefore to control blood glucose. It is thinkable that the inflammation from the pancreatitis destroy β cells that produce insulin,or that the inflammation block the release of insulin . Another possibility that the body is less able to use insulin to regulate blood sugar this is called " insulin resistance " due to choronic pancreatitis [35].

Blood sugar, Insulin and cholesterol interact with each other in the body, and are affected by each other. Hypertriglyceridemia and low HDL-C may also induce disturbances of glucose metabolism and may thus be the consequence and the source of hyperglycemia [36].

Lipids are a class of molecules in the body that include hormones,fats,oils and waxes which are essential for good health, but they can also contribute to diseases .

In both sexes serum TC , TG , LDL-C , VLDL, Risk ratio I and Risk ratio II showed significant increase in all groups . Yet, serum HDL-C level showed significant decrease in all groups.

Genetic engineering study have developed cereals with increased oil for food, feed, and industrial application [11], so increased oil content in GM food may lead to the increase of cholesterol level.

Another possible explanation for hyperlipidemia in blood attributed the elevation in total serum (cholesterol, triglycerides, LDL, and VLDL) and moreover the decrease in HDL will lead to the blockage of liver bile ducts causing reduction or cessation of its secretion to the duodenum subsequently causing cholestasis [37, 38].

Another possibility for the increase of Serum TC, TG, VLDL, and LDL in transgenic maize group, this marked hyperlipidemia in blood characterizes the diabetic state, as a matter of fact higher glucose levels. The diabetic condition can therefore be regarded as a consequence of the uninhibited action of lipolytic hormones on fat deposits. Excess of fatty acids in plasma promoted liver conversion of some fatty acids to phospholipids and cholesterol. These two substances, along with excess of triglycerides formed in the liver, may be discharged into lipoproteins in the blood [39].

With the huge increase in GM crops, concerns whether these foods are beneficial or harmful have risen in the community. Our findings indicated that they have adverse effects on human health, so we advise against using them and better replace with organic foods.

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الملخص العربي

تأثير الغذاء المعدل وراثيا على هرمون الأنسولين والجلوكوز والدهون في ذكور وإناث الجرذان البيضاء

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الملخص العربي

في السنوات الأخيرة ، كانت المحاصيل المعدلة وراثيًا تهدف إلى إنتاج الغذاء / الأعلاف التي أصبحت جزءًا من الزراعة المعتاده في العديد من مناطق العالم . لا يزال من غير الواضح ما إذا كانت الأغذية والأعلاف المعدلة وراثيًا لها تأثيرات جيده او ضاره على البشر أو الحيوانات. لذلك ، صممت هذه الدراسه لتقييم تأثير الأغذيه المعدله وراثيًا على هرمون الأنسولين والجلوكوز والدهون ووزن الجسم , تم استخدام ذكور وإناث الجرذان البيضاء بمتوسط وزن من 70 الي 80 جرام في هذه الدراسة. تم تقسيم كل جنس إلى أربعة مجموعات (عدد = 10 لكل مجموعة). تغذت المجموعة الضابطة على النظام الغذائي الأساسي للمعهد الأمريكي للتغذية من أجل النمو (AIN93 G) وثلاث مجموعات مُعالجة أعطيت الذرة , القمح والأرز المعدل وراثيا والمياه لمدة ثلاثة أشهر . السبب في اختيار هذه الاطعمه لأنها من أكثر الأطعمه الأساسيه التي نستخدمها في حياتنا اليوميه (الخبز و الأرز) .

في نهاية التجربة أظهرت النتائج أن المجموعات المعدلة وراثيًا (ذرة ، قمح ، أرز) لكلا الجنسين انخفاضاً معنوياً في الأنسولين في الدم وزيادة معنوية في نسبة الجلوكوز في الدم. أيضًا ، زيادة كبيرة في مستوي الكوليسترول و الدهون الثلاثيه و مستوى البروتين الدهني منخفض الكثافة وزادت البروتينات الدهنية منخفضة الكثافة جدا ونسبة الخطر 1 ونسبة الخطر 2. علاوة على ذلك ، أظهر مستوى كوليسترول البروتينات الدهنية عالية الكثافة في الدم انخفاضًا معنويًا في جميع المجموعات , كما أظهر وزن الجسم زيادة معنوية في جميع مجموعات ذكور وإناث الجرذان بالمقارنه بالمجوعة الضابطة .