

# Efficacy of Ginger (*Zingiber officinale* Roscoe) Extracts in Lowering Blood Glucose in Normal and High Fat Diet-induced Diabetic Rats

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**Abstract** Even though the hypoglycemic effect of various extracts of ginger had been delved into exhaustively the similar effect of the cooked form of the spice is yet to be ascertained. This is of vital importance since ginger is mostly consumed in cooked form in various dishes. Hence, the objective of this study is to determine the efficacy of raw and cooked ginger extracts in lowering blood glucose in normal and high fat diet-induced diabetic rats, an experimental model of Type 2 diabetes which is the most prevalent type of the disease. Male Albino rats (63) were divided into seven groups and designated thus: Group 1 – normal negative control, Group 2 – normal rats given raw ginger extract, Group 3 - normal rats given cooked ginger extract, Group 4 - diabetic control, Group 5 –diabetic rats given raw ginger extract, Group 6 – diabetic rats given cooked ginger extract and Group 7 – diabetic rats given Metformin. The diabetic groups were fed high fat diet for 12 weeks after which the 4 weeks extracts administration commenced Fasting blood glucose was determined before and after the 12 weeks diet introduction and at the 2<sup>nd</sup> and 4<sup>th</sup> weeks of extracts' administration by using ACCU-CHEK Active Glucometer, Roche, Germany. ANOVA and Least Significant Difference were used for statistical analyses. There was no significant difference between. Raw ginger extract and Metformin normalized fasting blood glucose (FBG) in the diabetic rats because there was no significant difference ( $p < 0.05$ ) between these two groups and the normal negative control at 4 weeks extracts and drug administration. The cooked extract did not normalize the blood glucose but lowered it by 35%. The two extracts had similar hypoglycemic effect (24% reduction,  $p < 0.05$ ) in normal rats at 2 weeks and 4 weeks of administration. Hence raw ginger extract is as effective as Merformin in normalizing FBG but the cooked form may require a longer period to exert similar effect. Even though the extracts lowered the FBG below normal in normal rats this may not lead to clinically threatening hypoglycemia.

**Keywords:** *cooked ginger extract, high fat diet, diabetes*

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## 1. Introduction

Excess calorie intake can lead to obesity as well as insulin resistance which precipitates hyperglycemia, a common pathway in the pathogenesis of Type 2 diabetes which is the most prevalent type of the disease globally. The continual advancement in technology exerts a positive trend on civilization, computerization, improved transport systems, increased access to instant, convenience and ready made meals which culminate into sedentary lifestyle that promotes inactivity, obesity and poor food choices and habits. The rapid increase in the global prevalence of diabetes from the early part of the 21<sup>st</sup> century when the world witnessed the most rapid advancement in computerization is a notable evidence of concern in categorizing diabetes mellitus as a public health threat.

Globally the prevalence was estimated to increase in year 2000 to 2010 from 14.2 million to 17.5 million in North America, 15.6 million to 22.5 million in South America, 26.5 million to 32.9 million in Europe, 9.4 million to 14.1 million in Africa, 84.5 million to 132.2 million in Asia and 1.0 million to 1.3 million in Australia giving a total global increase in prevalence from 151 million people in 2000 to 221 million people in 2010 (Amos et al., 1997). This was projected to 324 million by 2025 (Zimmet et al., 2003) and 366 million 2030 (Wild et al., 2004). In 2013, 382 million people had diabetes mellitus worldwide and this is expected to rise to 592 million by 2035 ( Guariguata et al., 2014). Hence an effective, easy, cheap and available regimen is required to combat this social ill.

Spices which have been known to improve the sensory properties of foods have also been appreciated for their medicinal values. Ginger (*Zingiber officinale*) has been

identified as a hypoglycemic food adjunct in both laboratory animals and human experimental protocols. Specifically, ginger powder in different doses have been used in the management of Type 2 diabetes in human subjects (Arablou et al., 2014; Mozaffari-Khosravi et al., 2014; Mahluji et al., 2013) while its aqueous and ethanol extracts have been reported to be effective in animal models of high fat diet-induced type 2 diabetes (Shadli et al., 2014; Li et al., 2014) but the hypoglycemic effect of the cooked form of ginger juice has not been ascertained. This is an abject deficit in knowledge since ginger is mostly consumed in cooked form in various dishes such as soups, stews, sauces, sweet and savory puddings, grills, roasts etc. Also the undesirable side effects of metformin, an anti diabetic drug commonly used in the management of type 2 diabetes, such as: gastrointestinal disorders (nausea, vomiting, flatulence, anorexia, diarrhea, dyspepsia); anemia; lactic acidosis; reduced vitamin B<sub>12</sub> absorption; as well as the uncertainty of its use during pregnancy and lactation; demands the exploration of the concept of the use of ginger as an anti diabetic food adjunct.

There exist conflicts in past scientific reports about the hypoglycemic effect of different ginger extracts. Islam and Choi (2008) reported no change in fasting blood glucose of type 2-induced diabetic rats, Weidner and Sigwart reported similar effect of ethanol ginger extract in normal rats while Singhal and Joshi 1983 reported an elevation of blood glucose in normal rats treated with ginger powder. However, significant hypoglycemic effect ginger juice in diabetic rats was reported by Sharma and Shukla (1977), ethanol extract in normal rabbits (Mascolo et al, 1989), in rats (Ojewole, 2006) and diabetic rats (Al-Amin et al, 2006.; Ojewole 2006 and Kar et al, 2003), but the hypoglycemic effect of cooked ginger extract is yet to be ascertained. Hence, this study determined the hypoglycemic effect of raw and cooked ginger extracts in normal and high fat diet-induced diabetes.

## 2. Materials and Methods

### 2.1. Extracts Preparation

Ginger rhizomes were purchased from Bodija market in Ibadan, Nigeria. The raw extract was prepared according using the method of Elshater et al., 2009 with slight modification. Ginger rhizomes were washed, weighed, peeled, weighed and wet-milled using plate attrition mill (Burh mill, France). The smooth slurry was sieved using cheese cloth the raw extract was stored in plastic jars at 2°C until use.

Cooked ginger was prepared by boiling the raw ginger extract for 1 hour on the medium burner of a 3-burner Thermo cool gas cooker, India. This was allowed to cool and stored in a plastic jar at 2°C until use.

### 2.2. Formulation of High Fat Diet (HFD)

High fat diet was formulated using the method of Panchal et al., 2011 with slight modification. The composition was as follows: 45% normal rat pellets, 30% beef tallow, 20% full cream milk powder and 5% sugar.

### 2.3. Collection of Rats

Eleven weeks old male albino rats (63) of weight range 120-160g were purchased from the animal house of the Department of Veterinary Physiology, University of Ibadan. The rats were fed rat pellets and tap water ad libitum for the period of acclimatization. All animals were treated in accordance with the ethical procedure as approved by the University of Ibadan/ University College Hospital Ethical Review Committee.

### 2.4. Experimentation

The groups of rats as designated treated thus: Group 1 – rats fed with normal rats pellets for 12 weeks and 2ml/kg body weight distilled water orally for the following 4 weeks, Group 2 - rats fed with normal rats pellets and given oral administration of raw ginger extract ( 2ml/kg body weight) for 4 weeks, Group 3- rats fed with normal diet and given cooked ginger extract, Group 4- rats fed with HFD and given distilled water, Group 5- rats fed with HFD and given raw ginger extract, Group 6- rats fed with HFD and given cooked ginger extract and Group 7- rats fed with HFD and given Metformin- 200mg/kg body weight (Zheng et al., 2012), Hovid Diabetamin, Malaysia. The dosage of extracts used by Elshater et al 2009 (2ml/kg b weight) was applied.

### 2.5. Fasting Blood Glucose

Blood samples were taken from the tail end of the animals before HFD introduction, After 12 weeks HFD and at the end of the 2<sup>nd</sup> and 4<sup>th</sup> weeks extracts administration from overnight fasted rats. The blood glucose was determined using ACCUCHEK Active Glucometer and strips, Roche, Germany. Animals were sacrificed at the end of the experiment by cervical dislocation.

### 2.6. Statistical Analysis

Data were expressed as means ± standard deviation. Analysis of Variance was used to compare the data in the seven groups while Least Significant Difference was used for comparison between one group and the other (p< 0.05).

## 3. Results and Discussion

### 3.1. Animal Weights

There was no significant difference in the weight of the animals between all groups of rats before the introduction of the HFD ( Table 1) but after the 12 weeks high fat diet (HFD) consumption the difference in weight between the normal and HFD groups was about 82.2g (34.7% increase).. At 2 weeks of ginger administration there existed significant differences (p<0.05) between all the HFD-fed groups. This difference was more noticeable in Groups 6 and 7 at 4 weeks of extracts administration. The highest weight reduction was observed in HFD-fed rats that were given cooked ginger juice followed by the drug-treated group, thus confirming weight reduction as one of the side effects of the drug.

There was no significant difference (p<0.05) in FBG (fasting blood glucose) in all the groups before the introduction of the HFD. The consumption of HFD for 3 months increased the fasting blood glucose (FBG) from

107.89mg/dl in the negative control to 181.64 in the diabetic groups (Table 2). This corroborates past findings that reported induction of hyperglycemia (fasting blood

glucose  $\geq 170$  mg/dl) with chronic high fat diet consumption (Magao et al., 2012; Zong et al., 2012; Akerfiedt and Laybut, 2011; Panchal et al., 2011).

**Table 1. Weight of rats during experimentation**

Groups	B HFD (g)	12 HFD (g)	2W GINGER (g)	4W GINGER (g)
Group1	157.22 $\pm$ 7.79	239.44 $\pm$ 9.68	253.89 $\pm$ 11.32	267.11 $\pm$ 13.68
Group2	154.89 $\pm$ 7.19	233.22 $\pm$ 8.77	240.03 $\pm$ 8.83	253.11 $\pm$ 8.33
Group3	155.02 $\pm$ 7.07	237.56 $\pm$ 6.44	250.22 $\pm$ 6.04	263.05 $\pm$ 5.79
Group4	155.22 $\pm$ 8.12	317.67 $\pm$ 15.35	335.44 $\pm$ 14.98	338.22 $\pm$ 16.81
Group5	158.04 $\pm$ 7.95	322.44 $\pm$ 19.60	329.56 $\pm$ 15.16	331.78 $\pm$ 10.06
Group6	155.08 $\pm$ 8.28	314.22 $\pm$ 20.68	279.25 $\pm$ 27.78	231.29 $\pm$ 32.27
Group7	154.33 $\pm$ 6.20	321.44 $\pm$ 11.18	310.33 $\pm$ 15.70	257.89 $\pm$ 21.92

B HFD- Weight of rats before introduction of high fat diet (HFD).

12 HFD- weight of rats after 12 weeks of HFD.

2W GINGER- weight of rats after 2 weeks of ginger extracts administration.

4W GINGER- weight of rats after 4 weeks of ginger administration

**Table 2. Effect of raw and cooked ginger extracts on blood glucose in normal and HFD-induced diabetic rats**

Groups	A FBG (mg/dl)	B FBG (mg/dl)	2 FBG (mg/dl)	4 FBG (mg/dl)
Group 1	110.11 $\pm$ 6.49	107.89 $\pm$ 8.57	109.56 $\pm$ 4.82	109.33 $\pm$ 5.81
Group 2	111.00 $\pm$ 5.31	106.56 $\pm$ 6.00	82.56 $\pm$ 7.72	84.33 $\pm$ 3.00
Group 3	111.00 $\pm$ 3.80	109.44 $\pm$ 5.20	84.11 $\pm$ 3.55	85.00 $\pm$ 3.39
Group 4	112.67 $\pm$ 4.12	182.22 $\pm$ 15.43	199.00 $\pm$ 5.85	213.56 $\pm$ 9.18
Group 5	110.56 $\pm$ 5.27	184.33 $\pm$ 6.98	148.78 $\pm$ 5.87	114.67 $\pm$ 6.42
Group 6	111.78 $\pm$ 2.33	183.56 $\pm$ 5.53	164.63 $\pm$ 4.44	138.86 $\pm$ 5.70
Group 6	111.33 $\pm$ 4.52	176.44 $\pm$ 13.42	143.33 $\pm$ 6.42	112.33 $\pm$ 7.00

FBG- Fasting blood glucose before introduction of HFD.

B FBG- Fasting blood glucose after 12 weeks of HFD consumption.

2 FBG- Fasting blood glucose after 2 weeks of extracts administration

4FBG- Fasting blood glucose after 4 weeks of extracts administration.

Raw and cooked ginger extracts lowered blood glucose by 24% in normal rats at 2 weeks of extracts administration and this reduction seems to be constant till the end of the 4<sup>th</sup> week. This shows that longer term consumption of this spice may not reduce the FBG lower than this level, hence clinically threatening hypoglycemia may not occur. The efficacy raw ginger extract in lowering FBG is similar to that of Metformin at the dosages used both at 2 weeks and 4 weeks of administration ( $p < 0.05$ ) but the cooked extract was not as effective nevertheless longer term administration may exert similar desirable effect. At the end of 4 weeks extract administration, raw extract and the drug significantly lowered FBG to normal level ( $p < 0.05$ ) hence it can be deduced that raw ginger extract at 2ml/kg body weight was as effective as Metformin (180mg/kg body weight) in lowering blood glucose in HFD- induced diabetes to normal level. Specifically, Metformin, raw and cooked ginger extracts lowered blood glucose in diabetic rats from 213.56mg/dl in the diabetic control group to 112.56, 114.67 and 138.86 mg/dl respectively (Table 2). This is comparable to the report of Nammi et al, 2009 in which ethanol ginger extract and Rosiglitazone (anti diabetic drug) reduced fasting blood glucose from 208.8mg/dl in HFD-induced diabetic rats 93.1 and 118.8mg/dl respectively. This hypoglycemic effect was more effective than the effect of ginger juice as reported by Elshater et al, 2009 who reported the lowering of plasma glucose from 370mg/dl in diabetic control group to 241mg/dl in the treated group.

## 4. Conclusion

Both raw and cooked ginger extracts lowered blood glucose in high fat diet-induced diabetic rats but the former was as effective as Metformin in lowering this parameter to normal level, and the cooked extract may require longer period to produce similar effect, hence, incorporating ginger into meals in dietary management of diabetes may be an effective regimen which is affordable and easy to apply but further study is recommended to make the cooked form of the spice to be as effective as the raw form. Also ginger is safe for consumption in normal states though both extracts reduced blood glucose but this did not reduced beyond normal range, hence, it may not cause marked hypoglycemia.

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