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FiberCreme Addition in Rice Increases the Dietary Fiber, Resistant Starch and Decreases Glycemic Index

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***Abstract*— A study on the addition of FiberCreme in cooking of rice has been conducted. The aim was to evaluate the effect of adding FiberCreme when cooking rice on chemical composition, dietary fiber and resistant starch of cooked rice as well as the glycemic index of rice with FiberCreme added. FiberCreme is a non-dairy creamer composed of coconut oil as the source of fat and dietary fiber as source of carbohydrate substituting sucrose in the traditional creamer. FiberCreme with different fiber sources were used including isomalto oligosaccharides (FC01), inulin (FC05) and isomaltodextrin (FC14). The FiberCreme added was 12% of weight of the rice grain. The addition of FiberCreme in cooked rice increase the total fat content from 0.33% (control rice) to 3.17%-3.33% (FiberCreme rice) but decrease the total carbohydrates content to 89.18%-89.43%, the total dietary fiber increase by 5.18%, 2.76% dan 4.5% in FC01, FC05 and FC14, respectively, and the resistant starch increase from 3.40% (control rice) to 5.11% (FC01 rice), 5.21% (FC05 rice) and 4.92% (FC14 rice), respectively. In human studies, it showed that addition of FiberCreme decrease the Glycemic Index (GI) of FiberCreme added cooked rice to 73.8 (FC01 rice), 70.7 (FC05 rice) and 76.5(FC14 rice) compared to 79.8 (control rice).**

***Keywords*— FiberCreme, dietary fiber, resistant starch, inulin, IMO, isomaltodextrin, glycemic index**

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I. INTRODUCTION

Diabetes mellitus (DM) is a metabolic condition characterized by chronic hyperglycemia caused by impaired insulin secretion or insulin processing [1]. According to the International Diabetic Federation (IDF) [2], the worldwide prevalence of diabetes reached 537 million people in 2021 and is expected to rise to 783 million people by 2045 if strong preventive measures are not adopted. In Indonesia, the figures are similar. In 2021, there were 19.5 million diabetic persons, and by 2045, it is anticipated that 28.6 million Indonesians will suffer from DM. The number of fatalities in Indonesia due to DM has become the 3rd highest amoung non-communicable diseases. Consuming a low glycemix index (GI) carbohydrate diet is one of the protective measures. Rice is Indonesians primary source of carbohydrates. White polished rice is more commonly consumed by Indonesians compared to brown rice. However, white polished rice, depend on the type of rice, has a higher GI level than brown rice , it is not ideal for diabetics [3].

The number GI level is lowered by increasing the concentration of resistance starch and dietary fiber. Resistant Starch content of food increases during food processing due starch retrogradation and dietary fiber content can be increased by adding fiber into the food. FiberCreme is one of example of food products which is rich of dietary fiber [4]. FiberCreme is a commercial non-dairy creamer that uses a variety of oligosaccharides as a source of fiber to replace the glucose component of conventional creamer combined with healthy oils as a palatable functional ingredient. Oligosaccharides as the source of fiber component contributes to 30-34% portion of FiberCremes ingredients [5].

According to American Association of Cereal Chemists (AACC) oligosaccharide is part of food fiber [6]. There are three types of FiberCreme namely FC01, FC05 and FC14 which acquire its fiber source from Isomaltooligosaccharides (IMO), Inulin and isomaltodextrin (IMD), respectively. These fiber sources are listed by The Food Directory of Canadas Health Department as the allowed fiber source in food products, whereas IMO and IMD are categorized as novel fibers and inulin is a traditional fiber [7].

FiberCreme is a type of food ingredient that contains vegetable fats and oligosaccharides, including IMO, inulin and IMD with a concentration of 61.1%. IMO consists of isomaltotriose, panose, isomaltose, and maltose, with α-1,6 or α-1,4 glucose bonds and glucose [8]. IMO has been shown to be able to lower blood sugar, increase the GLP-1 hormone [9]. Inulin is a reserve carbohydrate in various types of plants, in the form of fructans with degrees of polymerization (DP) varying from 2 to 60, connected by β-bonds (2-1) and ending in the form of a glucose unit [10]. Inulin is an oligosaccharide which cannot be enzymatically digested in the small intestine and will undergo fermentation in the colon. Regarding the effect of inulin as a source of fiber, Bonsu and Johnson [11], reported that type 2 diabetics consumed 10 grams of inulin every day for 12 weeks had no effect on glucose and lipid levels.

A study conducted on STZ-induced diabetic rats reported that inulin administered orally as much as 3 g/kg body weight for 12 weeks significantly reduced fasting glucose [12]. Another study compared the glucose-lowering effect between Konjac-inulin (KI) and inulin extract in STZ-induced diabetic rats found that consumption of KI combination for 28 days lowered glucose better than single ingredient of inulin extract [13]. IMD is a soluble dietary fiber produced by reacting starch with α-glucosyltransferase and α-amylase enzymes produced from *Paenibacillus alginolyticus*; Chemically, IMD is a multi-branched α-glucan which has a molecular weight of around 5000, is easily soluble in water and contains at least 80% db of dietary fiber [14]. Sadakiyo, et al. reported that IMD reduced postprandial glucose in a study involving 15 healthy volunteers who consumed 5 grams of IMD per day [15]. It was further reported from in vitro studies that decreased glucose levels were the result of the inhibition of glucose absorption in the intestine by IMD. Other researchers reported that in 50 healthy volunteers, administration of 2.5 g of IMD lowered postprandial blood glucose [16]. Similar results were also reported by Sakurai et al. that in 30 healthy volunteers giving IMD (2.93 gr) after breakfast reduced postprandial sugar levels [17].

Research to identify the hypoglycemic properties of FiberCreme has been conducted by Marsono et al., substitution of dietary fiber with FiberCreme to the diet was fed to hypercholesterolemic-diabetic rats for four weeks. It was found that there is a significant decrease of glucose level and lipid profile improvement [5]. The other research also reveals that the substitution of sucrose as the sweetener with IMO and FC01 in instant banana porridge products successfully decreases the plasma glucose, triglyceride, and cholesterol concentration of diabetic rats. Futhermore the research also reports that the banana IMO and FiberCreme successfully lowered the plasma glucose concentration by inhibiting the absorbtion of glucose [18].

Research on addition of dietary fiber to lower of GI in parboiling rice has been conducted by Chintyadewi [4]. Two fiber sources are investigated using FiberCreme in several levels and are added to rice during cooking followed by drying. This study reported that addition of 12% of FiberCreme resulted in the best sensory characteristic. Parboiled rice with the addition of FiberCreme can reduce the GI of rice from 65.9 to 49.1. The addition of FiberCreme inulin in the parboiling process lowered the GI value to 46.4. The decrease in GI with the addition of FiberCreme was probably caused by an increase in rice fiber content with the addition of FiberCreme or due to the formation of RS5 because of the reaction between starch in rice and fat in FiberCreme [19].

The purpose of this research is to compare the chemical composition, physical characters, and Glycemic Index of FiberCreme added rice with the introduction of 12% FiberCreme which differs in fiber source (FC01, FC05 and FC14).

II. MATERIAL AND METHODS

A. Material

Polished rice of Central Ramos long grain variety was purchased from local market in Yogyakarta. FiberCreme FC01, FC05 and FC14 were purchased from PT. Lautan Natural Krimerindo (LNK) in Mojosari, East Java, Indonesia. Analytical grade chemicals, pepsine (Merck, Darmstadt, Germany), amylase and amyloglucosidase (Sigma-Aldrich Co., St. Louis, MO, USA) were purchased from local Chemical agency in Yogyakarta. D (+) glucose anhydrous glucose (Merck, Darmstadt, Germany) were used as a food reference in GI determination. Determination of plasma glucose concentration were analyzed using an Accu-check glucometer (Roche-Dianostic Germany) which were calibrated prior to be used as previously described (Wijanarko et al., 2016, Lestari et al., 2017).

B. Methods

Preparation of cooked rice

Preparation of FiberCreme added cooked rice was conducted as described in the study from Chintyadewi [4] with a minor modification. In brief, 100 g Sentra Ramos rice grain was cooked with the addition of 130 ml of water which contain

12 g of FiberCreme. Four variations of cooking were performed including cooking with addition of FiberCreme FC01, FC05, FC14 and control (without addition of FiberCreme). Rice was cooked in automatic electric rice cooker (Sanken SJ-130SP rice cooker, power output 300 W, 1000 mL, PT. Sanken Argadwija, Indonesia) for around 20 min (automatic off) and keep in a room temperature for 10 min before the cooked rice were taken out.

Determination of dietary fiber

Dietary fiber was measured using a method of Asp et al [19]. Insoluble dietary fiber (IDF) and soluble dietary fiber (SDF) were determined in the following way, 1 g of sample and duplicate were weighed with an accuracy of 0.1 mg and put in a 500 ml Erlenmeyer container, then added Sodium phosphate (25 ml, 0.1 M, pH 6.0), then the sample was deposited and then added Termamyl 120 L (100 µL, Novo US industry), the container was covered with aluminum foil. Afterwards, the container was put in shaker incubator at 80ºC for 15 minutes. The container was cooled before 20 ml of distilled water was added, and the pH was adjusted to 1.5 with 4 M HCl. Then 100 mg pepsin was added to the container, then the container was closed and put in waterbath shaker incubator in 40ºC for 60 minutes. After the container was cooled, 20 ml of distilled water was added, and the pH was adjusted to 6.8 with 4 M NaOH. Next, 100 mg of pancreatin was added into the container and the container was closed and incubated at 40ºC waterbath with a shaking for 60 minutes. Then the pH was adjusted to 4.5 with HCI, then the solution was filtered using a dry and weighed crucible containing 0.5 g of dried celite and washed with 2 x 10 ml of distilled water. The residual IDF was washed with 2 x 10 ml of 94% ethanol, cured at 105ºC overnight (D1), then weighed and ignited at 550ºC overnight (I1). SDF was measured by means, 400 ml of 94% warm ethanol (60ºC) was added to the filtrate, and the precipitate was left to form for 1 hour. The solution was filtered as before, then washed with 2 x 10 ml 78% and 94% ethanol. The precipitate (SDF) was dried at 105ºC overnight (D2), then weighed and ignored as in the IDF sample (I2). Blank values were obtained by following the procedure without samples. Dietary fiber content could be obtained using the formula:

$$\text{IDF} = \frac{(D1 - I1 - B1)}{W} x\ 100\% \quad (1)$$

$$\text{SDF} = \frac{(D2 - I2 - B2)}{W} x\ 100\% \quad (2)$$

Total dietary fiber = (1) + (2)

Description:

D = weight (g) after drying

I = weight (g) after the receipt

B = weight (g) ash free blank

W = sample weight (g)

Determination of Resistant starch

RS (resistant starch) was measured using the method of Goni et al. [20]. A 100 mg of BPS flour sample was inserted in a closed centrifuge tube, then 10 ml of KCL-HCL pH 1.5 buffer was then added to the cortex. Then 0.2 mL of pepsin solution (1 g pepsin / 10 mL KCL-HCl buffer) was added to the container and then cortex. Then the container was put in a 40ºC waterbath for 60 minutes with constant shaking. Next, the container was cooled at room temperature. After cooling into the container 9 mL 0.1 M Trismaleate buffer pH 6.9 was added, then added 1 mL of α-amylase solution (40 mg α-amylase per mL Trismaleate buffer). Then the container was incubated 16 hours on a 37ºC waterbath with constant shaking, next the tube container was put in centrifuge 3000 g for 15 minutes, then the supernatant was discarded and subsequently washed with 10 mL of distilled water. Then the tube was put in the centrifuge again and the supernatant was removed. A 3 mL of distilled water was carefully added and then added by 3 mL of KOH 4M. The container was put into a room temperature waterbath for 30 minutes with constant shaking. Then into the container was added 5.5 mL 2 M HCL and 3 mL 0.4 M sodium acetate buffer with a pH of 4.75. Then 80 µL amyloglucosidase was added to the container, mix well and put in a 60ºC waterbath for 45 minutes with constant shaking and centrifuged 3000g for 15 minutes and the supernatant was taken and stored in a volume tube, then the residue was washed with 10 mL of distilled water and centrifuged again. Next, the supernatant was collected, and the distilled water was added up to 50 mL. Then the standard curve was made from glucose solution (10-60 ppm) from GOD PAP reagent kit. Next, 0.5 ml sample was pipetted, water, and standard into the tube. Then added 1 mL of the GOD PAP reagent kit. Then put in a 37ºC waterbath for 30 minutes. Furthermore, it was monitored at 510 nm against the blank (5 minutes after incubation). RS was calculated using a standard curve. Resistant starch was calculated as mg glucose x 0.9.

Analysis of Glycemic Index (GI)

The GI of cooked rice were determined according to protocol describe by Marsono et al. [5]. Ten healthy subjects aged 22-26 years old with normal BMI of 19.10-24.01 and normal glucose profile (fasting and post prandial) were selected. All subjects signed the informed consent to participate in the study. The protocol of GI determination was approved by the Medical and Health Research Ethics Committee (MHREC), faculty of Medicine, Universitas Gadjah Mada (No.: KE/FK/080/EC/2019 dated July 16, 2019). They fasted for 8-10 hours prior to the GI test. The fasting plasma glucose concentration was measured. Then they consumed 50 gr glucose in 500 ml of water as the food reference. The blood glucose concentration of each subject was measured every 30 min over a period of 120 min after consuming the samples using a commercial kit consisting of an Accu-check

Glucometer (Roche-Diagnostics Germany). In the next day, the same procedure was conducted for the rice sample. The sample of test food contains 50 gr available carbohydrates. Available carbohydrates were calculated as total carbohydrates content minus the dietary fiber content. Data were plotted as time versus blood glucose level, with time as the X-axis and blood glucose concentration as the Y-axis. The area under curve (AUC) was determined for every blood glucose level of each sample, using the formula described by Wolever et. al., 1991. Based on the area under the curve, the GI was calculated using the following formula.

$$GI = \frac{AUC\ of\ the\ sample\ (test\ food)}{AUC\ of\ reference\ food\ (glucose)} \times 100 \quad (3)$$

Statistical analysis

Rice composition was analyzed using One-Way Analysis of Variance (ANOVA) followed by Duncan's multiple range test (DMTR) using the SPSS 18.0 Statistical Software Program. Each value of $p<0.05$ is statistically significant.

III. Result and Discussion

A. *Chemical composition of FiberCreme cooked rice*

The chemical composition of cooked rice with addition of FiberCreme (FC01, FC05 and FC14) was presented in **Table 1.**

TABLE I
CHEMICAL COMPOSITION OF CONTROL AND FIBERCREME RICE (FC01, FC05, AND FC14)

Composition	Sample			
	Control	FC01	FC05	FC14
Water (%wb)	54.14 ± 2.08^a	47.89 ± 5.19^b	47.77 ± 1.62^b	48.53 ± 1.07^b
Ash (%db)	0.34 ± 0.03^a	0.63 ± 0.07^b	0.64 ± 0.01^b	0.62 ± 0.01^b
Protein (%db)	6.99 ± 0.32^a	6.74 ± 0.4^a	6.84 ± 0.54^a	6.99 ± 0.5^a
Fat (%db)	0.33 ± 0.01^a	3.19 ± 0.16^b	3.33 ± 0.26^b	3.17 ± 0.34^b
Total carbohydrates, by difference (%db)	92.3 ± 0.39^a	89.43 ± 0.48^b	89.18 ± 0.57^b	89.22 ± 0.50^b
Soluble fiber (%db)	1.27 ± 0.13^a	1.88 ± 0.06^b	2.16 ± 0.01^c	4.41 ± 0.08^d
Insoluble fiber (%db)	5.68 ± 0.04^a	10.25 ± 0.25^d	7.55 ± 0.01^c	7.04 ± 0.10^b
Total dietary fiber (%db)	6.95 ± 0.18^a	12.13 ± 0.19^d	9.71 ± 0.00^b	11.45 ± 0.02^c
Resistant Starch (%db)	3.40 ± 0.01^a	5.11 ± 0.01^c	5.21 ± 0.06^d	4.92 ± 0.04^b

Superscripts with the same letters in a horizontal row were not significantly different ($p<0.05$)

Chemical composition including proximate, dietary fiber and resisitant starch content of FC01, FC05 and FC14 cooked rice presented in **Table 1**. In all treatments showed that there was similar trend in the composition of the rice. No significant change in ash and protein content but an increase of total fat was identified. The total fat content increase to 3.17% to 3.30% from the control rice of 0.33%. It can be argued that it was because of the fat content as one of the main contents in FiberCreme added to the rice. Chemically FiberCreme contain 30-34% of fat [21]. The increase of fiber content in the cooked rice has the implication on lowering the percentage of total carbohydrates to 2.87%-3.12% as shown in the **Table 1.**

B. *Changes of dietary fiber and resistant starch content in FiberCreme cooked rice*

There are two types of dietary fiber, soluble and insoluble fiber. Total dietary fiber consists of soluble and insoluble fiber, which were different in chemical composition, physical properties and fermentabilities. Soluble fiber is dissolvable and easily digestible by bacteria in the colon, insoluble fiber is more difficult to be broken by bacteria. Both fibers have different health effect to human body. Rice contains low soluble and insoluble fibe, therefore rice is not a potential source of dietary fiber. The addition of FiberCreme in rice was expected to increase their dietary fiber content. Dietary fiber content of FiberCreme added rice presented in **Table 1** showed that there was significant increase in the dietary fiber content ($p<0.05$) in the FiberCreme added cooked rice both in soluble and insoluble dietary fiber. The highest increase of soluble fiber was shown in the FC14 rice (4.41%) but for the insoluble dietary fiber was highest in the FC01 rice (10.25%).

It can be argued that this difference was due to the dietary fiber source of the FiberCreme added to the rice during cooking. Dietary fiber source in FiberCreme FC01, FC05 and FC14 are IMO, inulin and IMD, respectively. A list of dietary fiber reviewed and accepted by Health Canada's Food Directorate revealed that IMO and RMD are Novel Fibers and inulin is a traditional Fiber [7].

IMO is a resistant oligosaccharide with the main component are maltotriosa, panosa and isomaltriosa. A study reported that IMO produced from banana starch contains 53% isomaltotriosa, 21% isomaltotetraosa dan 26% maltooligoheptosa and several higher oligomers [22]. On other hand IMD is soluble fiber of α-glucan with many branches of α-1,6 glycocidic bond (49%) followed by α-1,4 glycocidic bond (19%) [16]. This structure resulted in lower insoluble fiber compared to IMO with the main component of triose and tetraose. The highest increase of total dietary fiber was found in the FC01 FiberCreme cooked rice (12.13%) which was dominated by insoluble fiber.

Resistant starch (RS) is the sum of starch and products of starch degradation not absorbed in the small intestine of healthy individuals [19]. Physiologically, according to the American Association of Cereal Chemists, RS is part of the dietary fiber as a carbohydrate analog [6]. Formerly, it was 4 types of RS including RS1, RS2, RS3 and RS4 [23]. Currently, it has been known other type of RS, called RS5. Basically, RS5 is a complex of amylo-lipid exist naturally in food or was formed during food processing [24]. **Table 1** showed a significant different increase of RS content between FC01, FC05 and FC14 rice. FC05 has the highest RS content (5.36%). Increasing of RS in cooked FiberCreme rice was caused by formation of amylose-lipid complex during cooking because of interaction between amylose of the rice and lipid in the FiberCreme. Similar finding was reported by Chintyadewi et al., precooked rice with addition of FiberCreme FC01 and FC05 increase RS content from 4.58% to 12.80% (FC01) and 12.40% (FC05) [4]. Anugrahati et al. reported that addition of coconut oil and coconut milk during cooking of rice increase the RS content of the cooked rice from 1.25% to 1.61% and 5.35%, respectively.

C. Glucose Response

To determine the GI value of FiberCreme cooked rice containing 50 gr equivalent of available carbohydrates were given to the volunteers. Weight of the samples were calculated based on the available carbohydrates content of the samples. **Table 2** showed the amount of rice samples consumed by the volunteers. The amount of rice samples equivalent to 50 g available carbohydrates of control rice 127.74 g, whereas FC01, FC05 and FC14 rice are 124.13 g, 120.46 g and 124.91 g, respectively.

TABLE II
WEIGHT OF RICE EQUIVALENT TO 50 G AVAILABLE CARBOHYDRATES TO BE CONSUMED BY THE VOLUNTEERS

	Control	FC01	FC05	FC14
Water, %wb	54.14	47.89	47.77	48.53
Total CHO, %wb	9.23	89.43	89.18	89.22
Total DF, %wb	6.95	12.13	9.71	11.45
Available CHO, %db	85.35	77.3	79.47	77.77
Available CHO, %wb	39.14	40.28	41.51	40.03
Weight of rice equivalent to 50 g available carbohydrates, g	127.74	124.13	120.46	124.91

Table 3 showed the glucose concentrations of volunteers consuming reference food (glucose), control rice and FiberCreme added cooked rice (FC01, FC 05 and FC 14). The glucose respond was determine using the blood glucose concentration after consumed reference food and cooked rice samples.

TABLE III
GLUCOSE CONCENTRATIONS (MG/DL) OF VOLUNTEERS (N=10) CONSUMING REFERENCE FOOD (GLUCOSE), CONTROL RICE, AND FIBERCREME RICE (FC01, FC05, FC14).

Sample	Time after ingestion of test meal (min)				
	0	30	60	90	120
Glucose	76.8	152.2	125.2	102.5	90.0
Control	77.8	133.0	115.2	102.1	91.4
FC01	78.3	124.1	104.9	107.5	105.0
FC05	80.1	131.4	115.1	97.3	93.9
FC14	78.9	135.1	109.5	102.0	97.9

Based on the data in table 3, it can be calculated the changes of blood glucose as presented in **Fig. 1.**

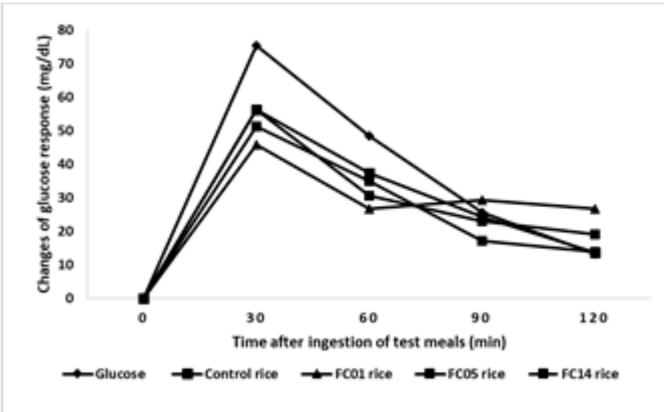

Fig.1 Changes in blood glucose concentration of volunteers after consuming standard glucose, control rice and FiberCreme rice (FC01, FC05 and FC14)

Based on the data presented in **Fig. 1**, the area under curve (AUC) was determined for every blood glucose level of each sample. The hypothesis that soluble fiber can inhibit glucose absorption depends on the idea that soluble fiber viscosity might prevent glucose absorption. Nevertheless, considering that the oligosaccharides in FiberCreme are not viscous [21], the soluble fiber content of FiberCreme rice has no effect on its glycemic index score. Jenkins et al., claimed that there is no definitive relationship between dietary fiber content in a material and its glycemic index [26]. Varied forms of fiber have different effects on GI. For example, fiber from bread, rice, and pasta has a minor effect, whereas viscous fibers, such as pectin, guar, and galactomannan, have a large effect [27]. The lower GI of FiberCreme rice is most likely related to its fat content. The fat content in FiberCreme rice forms a bond with carbohydrates, preventing them from being detected by amylase enzyme, thereby reducing the digestion of carbohydrates. As a result it attenuates the glucose response (GR), preventing an increase in the glycemic index (GI) [28]. The fat content of FiberCreme rice was 10 times higher than the control rice, as indicated in **Table 1**. Fat can inhibit starch gelatinization thereby inhibiting gastric emptying. This results in a decrease in GR so that it can reduce the value of theGI.

TABLE IV
AREA UNDER CURVE (AUC) AND GLYCEMIC INDEX (GI)

Samples	Area Under Curve (AUC) (m/dL x min)	Changes Compare to Control (%)	Glycemic Index (GI)
Glucose	156.1	-	100.0
Control rice	124.6	-	79.8
FC01	115.1	↓7.6	73.8
FC05	110.4	↓11.4	70.7
FC14	119.4	↓4.2	76.5

Table 4 shows that consuming rice with the addition of FiberCreme decreases the GR determined by the total area under the GR curve (Total LDC). Rice FC01, FC05, and FC14 showed a 7.6%, 11.4%, and 4.2% decrease in GR when compared to control rice, respectively. The reduction in GR is not only related to its fat content but also to the oligosaccharides, which are the source of fiber in FiberCreme. The fat and fiber content in FiberCreme provides a double action in reducing the GI by attenuating the GR [28]. The oligosaccharides IMO, Inulin, and IMD are found in FC01, FC05, and FC14, respectively. Several studies have indicated that these three oligosaccharides have the capacity to reduce postprandial blood glucose rise or lower glucose responsiveness. Oku and Nakamura found that IMO can lower blood sugar levels [8]. Zhang et al., showed that the oral consumption of inulin as much as 3 g/kg body weight of a soluble dietary fiber product comprising 91% inulin-type fructan for 12 weeks effectively lowered fasting glucose in STZ-induced diabetes-induced rats [12].

According to Gao et al., inulin products from different sources have distinct benefits. After feeding inulin to diabetic rats for 28 days, Konjac-Inulin combination lowered glucose better than inulin extract [13]. Sadakiyo et al. found that consumption of 5 g of IMD per day can reduce postprandial hyperglycemia due to IMD's decrease in glucose absorption in the gut [17]. In the same year, Ishida et al. reported that 2.5 g IMD injected reduced postprandial blood glucose [29]. Sakurai et al. found that treatment of IMD (2.93 gr) after breakfast reduced postprandial sugar levels in 30 healthy participants [17].

The decrease in GR has consequences on the glycemic index value. From table 4 it can be seen that with glucose standards (GI = 100), the GI of the control rice sample was 79.8, the GI of the rice FC01, FC05 and FC14 were 73.8, 70.7 and 76.5 respectively. These data indicate that the addition of FiberCreme in rice lowers the GI of rice by 8% (rice FC01), 11% (rice FC05), and 4% (FC14), respectively. This decline has not been able to change the status of rice with a high GI. These results are similar to previous studies which reported that parboiled rice added with 12.9% FiberCreme FC05 had a lower GI (46.4) than parboiled rice added with FiberCreme FC01 (66.1). FiberCreme is a creamer containing soluble fiber and oligosaccharides as a carbohydrate source [4]. By looking at the fiber content (Table 1), it is noticeable that the soluble fiber content is 2.15% (rice FC01), 2.23% (rice FC05), and 4.41% (rice FC14). The soluble dietary data cannot explain the decrease in the rice glycemic index score.Conclusion

This research found that the addition of FiberCreme to rice before cooking not only increases the fat content and decreases the total carbohydrate content, but also increases the dietary fiber and resistant starch content. Consumption of FiberCreme added rice decreases the GR of FC01, FC05 and FC14 by 7.6%, 11.4% and 4.2% respectively, compared to the control rice. The addition of FiberCreme to cooking rice decrease the glycemic index value from 79.8 (rice control) to 76.5 (rice FC14) and 73.8 (rice FC01) and the lowest value was 70.7 (rice FC05). The consumption of rice prepared with the addition of FiberCreme holds potential for regulating GR, thereby offering an alternative carbohydrate source for people diagnosed with diabetes mellitus.

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CONFLICT OF INTEREST

Authors declare no conflict of interest to disclose.

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