Supporting Information for

Enhancement of the polymerase chain reaction by tungsten disulfide

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Content

1. The effect of WS_2 on PCR with the varied lengths of the PCR product.

The effect of WS_2 on PCR was studied by using the varied lengths of the PCR products with 291 bp and 205 bp, respectively. The sequences of primer used in the PCRs were forward primer F: CTG TTG CCT GTG GTA AGT GGG, reverse primer R: TGG TCA CAG TAT GCA GGA GGG for 291 bp length product and forward primer F: CTG TTG CCT GTG GTA AGT GGG, reverse primer R': GGG TGA TGT AGG GAT TGG TGG AGC for 205 bp length product, respectively. The oligonucleotide sequences were synthesized and purified by HPLC from TaKaRa Biotechnology Co. Ltd. (Dalian, China). The PCRs were performed in a 10 μL mixture containing 13.7 ng/μL of genomic DNA, 0.25 mM of dNTPs, 200 nM of forward and reverse primers, 1 μL of Taq™ Hot Start DNA Polymerase buffer (10 mM Tris-HCl pH 8.3, 50 mM KCl, 1.5 mM $MgCl_2$), 0.15 U of Taq™ Hot Start DNA Polymerase, and 5 μg/mL of WS_2 nanomaterials. The PCRs were carried out in the 2720 thermal cycler (Applied Biosystems), with the program of hot start at the 98 °C for 10 s, and 50 °C for 30 s, 72 °C for 1 min for 35 reaction cycles.

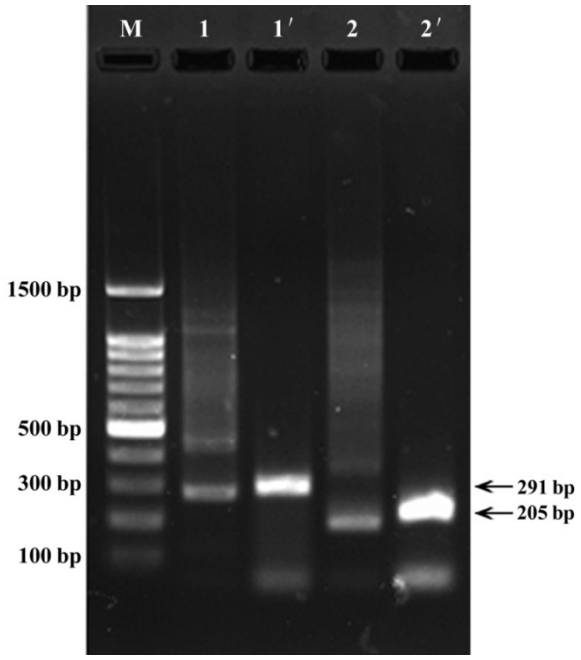

Fig. S1 The effect of WS_2 on PCR with the different lengths of the PCR product.

Fig. S1 was the agarose electrophoretic image of the PCR products. The bright bands in lane 1 and 1′ were the PCR products with 291 bp, resulting from the forword primer F and reverse primer R. The bright bands in lane 2 and 2′ were the PCR products with 205 bp from the forword primer F and reverse primer R′. Among them, the lane 1 and 2 were the PCR products in the absence of WS_2 including a series of diffuse bands, which could be attributed to the nonspecific PCR products. The lane 1′ and 2′ were the PCR products with the addition of WS_2, in which no remarkable diffuse bands were observed. Moreover, the bands from the specific PCR products by addition of WS_2 (lane 1′ and 2′) were much brighter than those in the absence of WS_2 (lane 1 and 2), indicating that WS_2 had the same enhancement effect on PCR with the sequence contexts of varied lengths of the PCR product.

2. Enhancement of PCR by WS_2 by using Phusion DNA polymerase.

To further prove the enhancement effect of WS_2 on PCR, we investigated the PCR performance with the other DNA polymerase, Phusion DNA polymerase at different annealing temperature. Phusion DNA Polymerase was purchased from Thermo Scientific Co., Ltd (Beijing, China). PCR reaction was performed in a 10 μL mixture containing 13.7 ng/μL of genomic DNA, 0.25 mM of dNTPs, 200 nM of forward primer F and reverse primer R, 2 μL of 5X Phusion HF Buffer (containing 7.5 mM $MgCl_2$), 0.1 U of Phusion DNA Polymerase (2 U/μL), and 5 μg/mL of WS_2 nanomaterials. The PCRs were carried out in the 2720 thermal cycler (Applied Biosystems, USA), with the program initial denaturation at the 98 °C for 30 s, and 98 °C for 10 s, 58 °C for 30 s, 72 °C for 1 min for 35 reaction cycles. After cycles, final extension was 72 °C for 8 min.

Then we investigated the enhancement effect of WS_2 on the PCR by using Phusion DNA polymerase at different annealing temperature. Fig. S2 showed the agarose electrophoretic image of the PCR products by using Phusion DNA polymerase without (lanes 1, 2 and 3) and with the addition of WS_2 (lanes 1', 2', and 3'), when the annealing temperature was 58°C (lanes 1 and 1'), 63°C (lanes 2 and 2') and 68°C (lanes 3 and 3'), respectively.

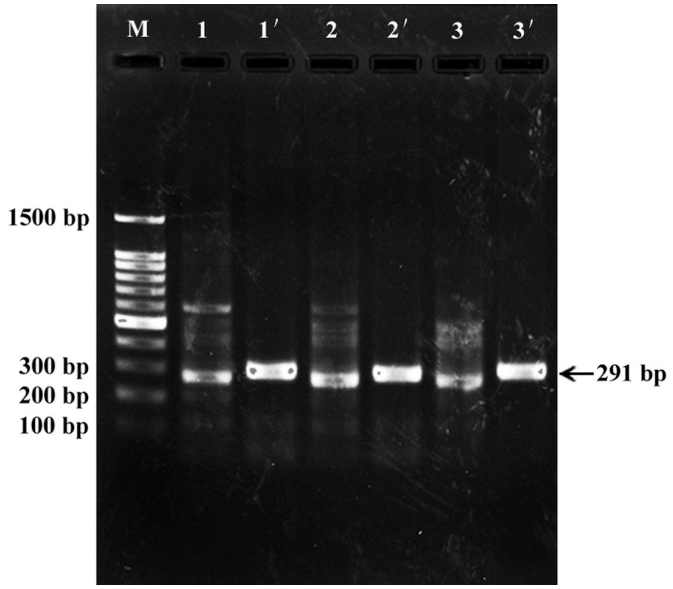

Fig. S2 Enhancement of PCR by WS_2 by using Phusion DNA polymerase

As shown in Fig. S2, it could be seen that there were some diffuse DNA bands in lane 1, 2 and 3, which were the nonspecific PCR products at the different annealing temperature. At the same time, the specific bands with 291 bp were observed in the lane 1, 2, and 3, respectively. By compared the band in lane 3 with those in lane 1 and lane 2, there are no remarkable improvement of PCR without WS_2 by enhancement of annealing temperature from 58 °C to 68 °C. On the other hand, a single specific bands of PCR products with 291 bp were obviously observed in lane 1', 2' and 3', respectively, which come from PCR with addition of WS_2 at the different annealing temperature. Moreover, at the same annealing temperature, the 291 bp bands of PCR products (lane 1', 2', and 3') by addition of WS_2 were much brighter

than those in the absence of WS_2 (lane 1, 2, and 3), respectively. These results suggested that the enhancement effect of WS_2 on PCR can also be achieved by PCR with Phusion DNA polymerase similar to Taq DNA Polymerase and where temperature optimization is not successful without WS_2.

3. The sequencing of the PCR products without and with WS_2.

The PCR products of 291 bp without and with the addition of WS_2 were first purified by a TaKaRa MiniBEST Agarose Gel DNA Extraction Kit and then sequenced by Sanger sequencing, which were performed with the primer F and primer R in the ABI PRISMTM 3730XL DNA Analyzer (Thermo Fisher Scientific). The map results of the bidirectional sequencing and the sequence assembly results were shown in Fig. S3 and Table S1, respectively. The results showed that the sequences of the PCR products with WS_2 were identical to those without WS_2, indicating that the addition of WS_2 would not affect the fidelity of DNA polymerase.

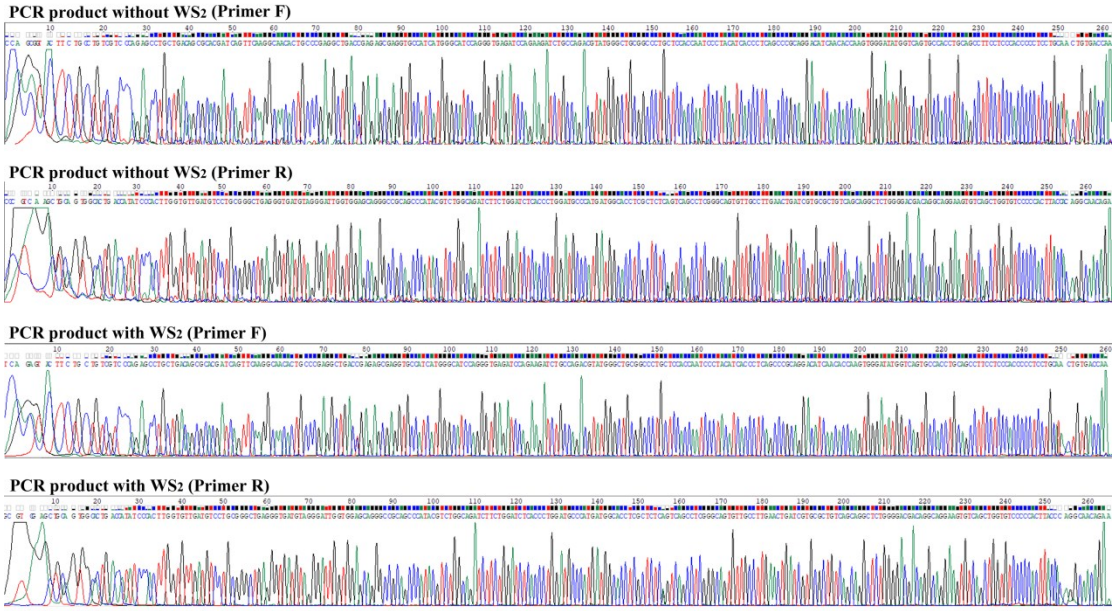

Fig. S3 The map of the bidirectional sequencing of PCR products

Table S1. The sequence assembly results of PCR products

PCR Products	Base sequences（5’-3’）
Without WS_2	CTGTTGCCTGTGGTAAGTGGGGGACACCAGCTGACACTTCCTGCCTGTCGTCCC CAGAGCCTGCTGACAGCGCACGATCAGTTCAAGGCAACACTGCCCGAGGCTGA CYGAGAGCGAGGTGCCATCATGGGCATCCAGGGTGAGATCCAGAAGATCTGC CAGACGTATGGGCTGCGGCCCTGCTCCACCAATCCCTACATCACCCTCAGCCCG CAGGACATCAACACCAAGTGGGATATGGTCAGTGCCACCTGCAGCCTTCCTCCC ACCCCCTCCTGCATACTGTGACCA
With WS_2	CTGTTGCCTGTGGTAAGTGGGGGACACCAGCTGACACTTCCTGCCTGTCGTCCC CAGAGCCTGCTGACAGCGCACGATCAGTTCAAGGCAACACTGCCCGAGGCTGA CYGAGAGCGAGGTGCCATCATGGGCATCCAGGGTGAGATCCAGAAGATCTGC CAGACGTATGGGCTGCGGCCCTGCTCCACCAATCCCTACATCACCCTCAGCCCG CAGGACATCAACACCAAGTGGGATATGGTCAGTGCCACCTGCAGCCTTCCTCCC ACCCCCTCCTGCATACTGTGACCA

Note. The Y base represented the heterozygote with base C or T.